PROCEEDINGS

OF THE

Lake Superior Mining Institute

EIGHTEENTH ANNUAL MEETING

MISSABE RANGE, MINN.

AUGUST 26, 27, 28, 29, 30, 1913

VOL. XVIII

ISHPEMING, MICH.
PUBLISHED BY THE INSTITUTE
AT THE OFFICE OF THE SECRETARY
1913

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PRESSES OF IRON ORE
ISHPEMING, MICH.

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OFFICERS.

For the Year Ending With the Close of the Annual Meeting, August 30th, 1913.

PRESIDENT.

PENTECOST MITCHELL .... Duluth, Minn.

(Term one year).

VICE PRESIDENTS.

GEO. H. ABEEL .... Ironwood, Mich.
†W. P. CHINN .... McKinley, Minn.
W. H. JOBE .... Palatka, Mich.

(Term expires 1913).

FRANCIS J. WEBB .... Duluth, Minn.
A. D. EDWARDS .... Atlantic Mine, Mich.

(Term expires 1914).

MANAGERS.

M. H. GODFREY .... Coleraine, Minn.
JAMES E. JOPLING .... Ishpeming, Mich.

(Term expires 1913).

G. S. BARBER .... Bessemer, Mich.
WM. H. JOHNSTON .... Ishpeming, Mich.
C. H. BAXTER .... Loretto, Mich.

(Term expires 1914).

TREASURER.

E. W. HOPKINS .... Commonwealth, Wis.

(Term expires 1913).

SECRETARY.

A. J. YUNGBLUTH .... Ishpeming, Mich.

(Term expires 1913).

(The above officers constitute the council).

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†To fill vacancy of Graham Pope, deceased.

OFFICERS.

The following is list of officers elected at the annual meeting, August 30th, 1913, also the officers holding over from the previous year which are indicated by *.

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WM. H. JOHNSTON ....Ishpeming, Mich.
(Term one year).

VICE PRESIDENTS.

*FRANCIS J. WEBB ....Duluth, Minn.
*A. D. EDWARDS ....Atlantic Mine, Mich.
(Term expires 1914).

CHARLES T. KRUSE ....Ishpeming, Mich.
CHARLES E. LAWRENCE ....Palatka, Mich.
LUTHER C. BREWER ....Ironwood, Mich.
(Term expires 1915).

MANAGERS.

*G. S. BARBER ....Bessemer, Mich.
*CHARLES H. BAXTER ....Loretto, Mich.
†STUART R. ELLIOTT ....Negaunee, Mich.
(Term expires 1914).

W. A. SIEBENTHAL ....Republic, Mich.
J. S. LUTES ....Biwabik, Minn.
(Term expires 1915).

TREASURER.

E. W. HOPKINS ....Commonwealth, Wis.
(Term one year).

SECRETARY.

A. J. YUNGBLUTH ....Ishpeming, Mich.
(Term one year).

(The above officers constitute the council).

---

†To fill vacancy of Wm. H. Johnston, elected to presidency.

LIST OF STANDING COMMITTEES FOR YEAR ENDING 1914.

PRACTICE FOR THE PREVENTION OF ACCIDENTS.

C. E. LAWRENCE, Chairman .... Palatka, Mich.
D. E. SUTHERLAND .... Iron Mountain, Mich.
WM. CONIBEAR .... Ishpeming, Mich.
W. H. SCHACHT .... Painesdale, Mich.
M. H. GODFREY .... Virginia, Minn.

CARE AND HANDLING OF HOISTING ROPES.

W. A. COLE, Chairman .... Ironwood, Mich.
O. D. M'CLURE .... Ishpeming, Mich.
J. S. JACKA .... Crystal Falls, Mich.
W. J. RICHARDS .... Painesdale, Mich.
A. TANCIG .... Hibbing, Minn.

PAPERS AND PUBLICATIONS.

WM. KELLY, Chairman .... Vulcan, Mich.
J. H. HEARDING .... Duluth, Minn.
F. W. M'NAIR .... Houghton, Mich.
J. E. JOPLING .... Ishpeming, Mich.
P. S. WILLIAMS .... Ramsay, Mich.

BUREAU OF MINES.

M. M. DUNCAN, Chairman .... Ishpeming, Mich.
J. B. COOPER .... Hubbell, Mich.
A. J. YUNGBLUTH, Secretary .... Ishpeming, Mich.

BIOGRAPHY.

J. H. HEARDING, Chairman .... Duluth, Minn.
J. B. COOPER .... Hubbell, Mich.
R. A. DOUGLAS .... Ironwood, Mich.
M. B. M'GEE .... Crystal Falls, Mich.
W. H. NEWETT .... Ishpeming, Mich.

MINING METHODS ON THE MARQUETTE RANGE.

Committee to consist of three members to be appointed later.

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POMPELLY, RAPHAEL ....Dublin, N. H.
VAN HISE, C. R......................................Madison, Wis.
WINCHELL, N. H...........501 East River Road, Minneapolis, Minn.

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SILLIMAN, A. P...................................Hibbing, Minn.

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ABEEL, GEO. H., JR. ....Ironwood, Mich.
ADAMS, DAVID T.............516 Providence Bldg., Duluth, Minn.
ADGATE, FREDERICK W..........419 Rookery Bldg., Chicago, Ills.
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ALLEN, R. C..Lansing, Mich.
AMBERG, J. W.......................1400 Fulton St., Chicago, Ills.
AMBERG, WILLIAM A...............1400 Fulton St., Chicago, Ills.
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APPLEBY, WILLIAM R........School of Mines, Minneapolis, Minn.
ARMSTRONG, FRANK H..............................Vulcan, Mich.
ATKINS, SAMUEL E..............909 Alworth Bldg., Duluth, Minn.

BAER, HENRY L...................................Hancock, Mich.
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BARABE, C. A.....................................Ishpeming, Mich.
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BELDEN, WILLIAM P............................Ishpeming, Mich.
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BREWER, CARL ....Ironwood, Mich.
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BROWN, JOHN JACOB.............................Carteret, N. J.
BURDORF, HARRY A......2316 Garfield Ave., S. Minneapolis, Minn.
BURNHAM, R.............936 Metropolitan Bldg., Minneapolis, Minn.
BURR, FLOYD L.....................................Vulcan, Mich.
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BUSH, E. G......................909 Alworth Bldg., Duluth, Minn.
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CHANNING, J. PARKE.................42 Broadway New York City
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CHEYNEY, H. C...................215 Jackson Blvd., Chicago, Ills.
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COLE, WILLIAM A...............................Ironwood, Mich.
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COLEMAN, MILTON W.............................Virginia, Minn.
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DICKERMAN, ALTON L. . . . . 70 State St., Boston, Mass.
DIEHL, ALFRED S. . . . . Coleraine, Minn.
DIEHL, G. E. . . . . 607 Wolvin Bldg., Duluth, Minn.
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DRAKE, FRANK . . . . 79 Milk St., Boston, Mass.
DRAKE, JOHN M. . . . . Hibbing, Minn.
DUDLEY, HARRY C. . . . . 807 Lonsdale Bldg., Duluth, Minn.
DUNCAN, MURRAY M. . . . . Ishpeming, Mich.
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FAIRCHILD, DAVID L. . . . . 616 Lonsdale Bldg., Duluth, Minn.
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GARDNER, OCTAVE D. . . . . Calumet, Mich.
GARDNER, W. A. 215 Jackson Blvd., Chicago, Ills.
GAY, JOSEPH E. . . . . 15 William St., New York City
GAYNOR, WILLIAM E. . . . . Duluth, Minn.
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HEIM, HARRY R....936 Metropolitan Life Bldg., Minneapolis, Minn.
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HOLTHOFF, HENRY C...............................Riverside, Ill.
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HULST, NELSON P..................300 Knapp St., Milwaukee, Wis.
HUNNER, EARL E..................610 Sellwood Bldg, Duluth, Minn.
HUNTER, ROY D........1506 Railway Exchange Bldg., Chicago, Ills.
HURTER, CHARLES S..............DuPont Bldg., Wilmington, Del.

IMHOFF, WALLACE G...............6805 Penn. Ave., Pittsburg, Pa.
IRELAND, JAMES D...............701 Sellwood Bldg., Duluth, Minn.

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JACKSON, C...Madison, Wis.
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JOHNSTONE, ORLAND W..........................Duluth, Minn.
JOLLY, JOHN ....Painesdale, Mich.
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JOPLING, JAMES E.............................Ishpeming, Mich.
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JORY, WILLIAM ....Princeton, Mich.

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KAUFMAN, HARRY L.............................Marquette, Mich.
KEARNEY, F. H................................Ironwood, Mich.
KEAST, WILLIAM J.............................Houghton, Mich.
KEESE, FRANK E...............................Ishpeming, Mich.
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KLEFFMAN, JOHN ....Hibbing, Minn.
KLINGLUND, F. D..............................Palmer, Mich.
KNAPP, GEO. F.............602 Rockefeller Bldg., Cleveland, Ohio
KNIGHT, J. B.................................Norway, Mich.
KNIGHT, R. C.................................Eveleth, Minn.
KNOX, JOHN JR................................Calumet, Mich.
KOEPEL, ED...................................Beacon Hill, Mich.
KRUSE, CHARLES T.............................Ishpeming, Mich.
KURTZMAN, P. L...............................McKinley, Minn.

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LAIST, ALEXANDER ....Hancock, Mich.
LAMBRIX, MICHAEL ....Hurley, Wis.
LAMONT, JOHN D...............................Virginia, Minn.
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LANG, S. S....................................Houghton, Mich.
LAROCHELLE, LOUIS ....Houghton, Mich.
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LASIER, F. G..................................Birmingham, Mich.
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LAWRENCE, CHARLES E...........................Palatka, Mich.
LAWTON, CHARLES L.............................Hancock, Mich.
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LEOPOLD, N. F....................108 Dearborn St., Chicago, Ills.
LETZ, JOHN F.......................662 12th St., Milwaukee, Wis.
LIBBY, DR. E. M...............................Iron River, Mich.
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LINN, A. E....................................Norway, Mich
LINSLEY, W. B.................................Escanaba, Mich
LOCHER, W. H..................................Duluth, Minn.
LONGYEAR, E. J........710 Security Bank Bldg., Minneapolis, Minn.
LONGYEAR, J. M................................Marquette, Mich.
LONSTORF, GEORGE J...........2301 Grand Ave., Milwaukee, Wis.
LOOK, WILLIAM F...............................Panama City, Fla.
LOUDENBACK, CLYDE I..........228 W. Randolph St., Chicago, Ills.
LUKEY, FRANK ....Hurley, Wis.
LUTES, J. S...................................Biwabik, Minn.
LUXMORE, THOMAS L............................Iron Mountain, Mich.
LYNCH, THOMAS F...............................Houghton, Mich

MAAS, ARTHUR E....................352 29th St., Milwaukee, Wis.
MAAS, GEORGE J................................Negaunee, Mich.
MACE, ROBERT E....................Wolvin Bldg., Duluth, Minn.
MACKILLICAN, JAMES A..........................Hibbing, Minn.
MACNAUGHTON, JAMES ....Calumet, Mich.
MACOMBER, F. B...............No. 507 S. Clinton St., Chicago, Ills.
MANVILLE, T. F. ....Madison Ave. and 41st Street, New York City
MARS, WILLIAM P...............................Duluth, Minn.
MARTIN, ALFRED ....Virginia, Minn.
MATHER, S. LIVINGSTON...........Rockefeller Bldg., Cleveland, O.
MATHER, WILLIAM G............Rockefeller Bldg., Cleveland, Ohio
MATTHEWS, WILLIAM C...........................Wilmington, Del.
MEADS, ALEXANDER P............................Marquette, Mich.
MERCER, HARRY T...............................Painesdale, Mich.
MEUCHE, A. H..................................Houghton, Mich.
MEYERS, WILLIAM R.............................Princeton, Mich.
MIDDLEMISE, BRUCE A...........................Hibbing, Minn.
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MILLS, FRANK P................................Kimberley, Nevada
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MITCHELL, R. J....................................Eveleth, Minn.
MITCHELL, WILLIAM A.......16th and Rockwell Sts., Chicago, Ills.
MITCHELL, SAMUEL J............................Marquette, Mich.
MITCHELL, HAROLD E..............................Eveleth, Minn.
MOELLER, FRANKLIN ....42 Chapman Ave., Cleveland, Ohio
MONROE, W. G..............................Iron Mountain, Mich.
MOORE, C. F..............920 Newhouse Bldg., Salt Lake City, Utah
MOORE, CLARENCE E...............................Virginia, Minn.
MORGAN, DAVID T. ....Detroit, Mich.
MORRIS, CHARLES S................2232 E. First St., Duluth, Minn.
MOWATT, NEVILLE P ....3rd Ave. and Michigan St., Duluth, Minn.
MULLEN, THOMAS M...............................Houghton, Mich.
MUNGER, CHARLES H...............................Duluth, Minn.
MUNROE, HENRY S...........Columbia University, New York City
MURRAY, ROBERT ....Hibbing, Minn.
MYERS, ALBERT J...........................Iron Mountain, Mich.
M'CLURE, O. D...................................Ishpeming, Mich.
M'CORMICK, EDWARD ....Negaunee, Mich.
M'DONALD, D. B....................................Duluth, Minn.
M'DOWELL, JOHN ....Hibbing, Minn.
M'GEE, M. B.................................Crystal Falls, Mich.
M'GONAGLE, WILLIAM A..............Wolvin Bldg., Duluth, Minn.
M'GREGOR, SILAS J..........................Iron Mountain, Mich.
M'INDOE, JAMES A..................................Norway, Mich.
M'INTYRE, JOHN E................................Nogales, Arizona
M'LAUGHLIN, W. J..................................Loretto, Mich.
M'LEAN, JOHN H....................................Duluth, Minn.
M'LEAN, RICHARD EARLE.................Wells, Delta Co., Mich.
M'NAMARA, THOMAS B............................Ironwood, Mich.
M'NAIR, F. W....................................Houghton, Mich.
M'NEIL, E. D......................................Virginia, Minn.
M'RANDLE, WILLIAM E. R.........................Bessemer, Mich.

NELSON, S. T......................1170 W. Lake St., Chicago, Ills.
NEWBY, WILLIAM ....Puritan P. O., N. Ironwood, Mich.
NEWETT, GEORGE A..............................Ishpeming, Mich.
NEWETT, W. H....................................Ishpeming, Mich.
NEWTON, L. L...................1324 La Salle Ave., Chicago, Ills.
NICHOLAS, THOMAS J...............................Palmer, Mich.
NICHOLS, F. W...................................Houghton, Mich.
NICKERSON, H. F.................................Houghton, Mich.
NIXON, JOHN A...................................Ishpeming, Mich.
NOBLE, THOMAS H...............................Marquette, Mich.
NOETZEL, BENJAMIN D.........................Trimountain, Mich.

OBERG, ANTON C..................................Hibbing, Minn.
OLCOTT, WILLIAM J.................................Duluth, Minn.

ORBISON, THOMAS W....................................Appleton, Wis.
ORR, FRANK D.......................Lyceum, Bldg., Duluth, Minn.
OSBORN, CHASE S..........................Sault Ste. Marie, Mich.
OVERPECK, HOLLIS W...................Box 617, Virginia, Minn.

PAINE, W. A.......................82 Devonshire St., Boston, Mass.
PAINE, FRANCIS W.................................Houghton, Mich.
PARKER, RICHARD A..............929 Foster Bldg., Denver, Colo.
PASCOE, PETER W..................................Republic, Mich.
PATRICK, RICHARD S.........314-15 Sellwood Block, Duluth, Minn.
PELLING, WILLIAM F. J., ...Carson Lake, Minn.
PENGILLY, EDWARD ....Crystal Falls, Mich.
PENNIMAN, DWIGHT C...........Clinton Hotel, Minneapolis Minn.
PENTON, JOHN A..............Iron Trade Review, Cleveland, Ohio
PERKINS, SAMUEL J...............................Ironwood, Mich.
PETERSON, A. Y....................................Chisholm, Minn.
PHILBIN, DONALD M............408 Sellwood Bldg., Duluth, Minn.
PHILLIPS, W. G......................................Calumet, Mich.
PITKIN, S. H.......................682 W. Market St., Akron, Ohio
POTTER, OCHA ....Houghton, Mich.
POWELL, D. W.....................................Marquette, Mich.
PRESCOTT, FRED M..................Oregon St., Milwaukee, Wis.
PRESCOTT, L. L.................................Menominee, Mich.
PRYOR, R. C.......................................Houghton, Mich.
PURSELL, H. E....................................Kewanee, Illinois

QUIGLEY, G. J..Antigo, Wis.
QUINE, JOHN THOMAS.............413 Vine St., Ishpeming, Mich.
QUINN, CLEMENT KRUSE..........................Virginia, Minn.

RAHT, CHARLES ....29 Broadway, New York City
RAISKY, F. H.....................................Ishpeming, Mich.
RALEY, ROBERT J...................Spalding Hotel, Duluth, Minn.
RANKIN, WILLIAM A..............................Painesdale, Mich.
RASHLEIGH, WILLIAM J...........................Aurora, Minn.
RAYMOND, HENRY A............Rockefeller Bldg., Cleveland, Ohio
REDFERN, JOHN A.....................................Hibbing, Minn.
REDNER, A. E..................216 Aurora location, Ironwood, Mich.
REEDER, J. T.......................................Houghton, Mich.
REEDER, EDWIN C................1917 Fisher Bldg., Chicago, Ills.
REEDER, J. H.......................................Houghton, Mich.
REHFUSS, LOUIS I..................................LaCrosse, Wis.
REIGART, JOHN R..................................Princeton, Mich.
REIFEL, H. T.......................................Nashwauk, Minn.
REYNOLDS, M. K...............430 E. Arch St., Marquette, Mich.
RICE, CLAUDE T. ....1420 Monadnock Bldg., Chicago, Ills.
RICE, JOHN H......................................Houghton, Mich.
RICHARDS, WILLIAM J.......................Crystal Falls, Mich.

RICHARDS, MORRIS EARL........................Virginia, Minn.
RICHARDS, WILLIAM J..........................Painesdale, Mich.
RICHEY, E. W.............211 Railway Exchange Bldg., Chicago, Ills.
RIDLEY, FREDERICK WILLIAM...................Calumet, Mich.
ROBERTS, HARRY ....Duluth, Minn.
ROBERTS, ALTON T.............................Marquette, Mich.
ROBERTSON, HUGH J............................Escanaba, Mich.
ROHN, OSCAR ....Butte, Mont.
ROSE, R. S......................................Marquette, Mich.
ROSKILLY, JOSEPH ....Virginia, Minn.
ROUCHLEAU, LOUIS ....Minneapolis, Minn.
ROUGH, JAMES H................................Negaunee, Mich.
ROWE, HENRY ....Ironwood, Mich.
ROWE, WM. C..................................Bessemer, Mich.
RUEZ, GEORGE F...............................Ishpeming, Mich.
RUMSEY, SPENCER S...............610 Wolvin Bldg., Duluth, Minn.
RUNDLE, A. J..............................Iron Mountain, Mich.
RYAN, JOHN A...............................Iron Mountain, Mich.

SALSICH, L. R..................................Coleraine, Minn.
SCADDEN, FRANK ....Crystal Falls, Mich.
SCHACHT, WILLIAM H..........................Painesdale, Mich.
SCHLESINGER H. J............................Milwaukee, Wis.
SCHUBERT, GEORGE P...........................Hancock, Mich.
SEAMAN, A. E..................................Houghton, Mich.
SEBENIUS, JOHN UNO................Wolvin Bldg., Duluth, Minn.
SEEBER, R. R....................................Winona, Mich.
SEELYE, R. W..........................Sault Ste. Marie, Ont.
SELLS, MAX ....Florence, Wis.
SELLWOOD, R. M..................................Duluth, Minn.
SENTER, A. W....................................Hubbell, Mich.
SHELDEN, R. SKIFF..............................Houghton, Mich.
SHELDON, ALBERT F............112 N. Arch St., Marquette, Mich.
SHERLOCK, THOMAS ....Escanaba, Mich.
SHERRERD, JOHN M............340 Spring Garden St., Easton, Pa.
SHIELDS, IRVIN J...............................Houghton, Mich.
SHOVE, BRIGHAM W..............................Ironwood, Mich.
SIEBENTHAL, W. A..............................Republic, Mich.
SILL, GEO. A....................504 Marquette Bldg., Chicago, Ills.
SILLIMAN, THOMAS B...........................Coleraine, Minn.
SILVER, C. R........................29 W. Lake St., Chicago, Ills.
SIMMONS, CHARLES ....Beacon, Mich.
SKINNER, MORTIMER B.558-560 W. Washington Blvd., Chicago, Ills.
SLINEY, DAVID J...............................Ishpeming, Mich.
SMITH, FRED ....Kearsarge, Mich.
SMITH, WILLARD J...............................Mohawk, Mich.
SMITH, CARL G.................................Kearsarge, Mich.

SMITH, ALFRED L................................Wakefield, Mich.
SMYTH, H. L........................Rotch Bldg., Cambridge, Mass.
SOADY, HARRY ....Duluth, Minn.
SPARKS, BENJAMIN F.............205 Ruby St., Houghton, Mich.
SPERR, F. W.....................................Houghton. Mich.
STAKEL, CHARLES J............................Ishpeming, Mich.
STANTON, F. McM..................208 5th Ave., New York City
STANTON, J. R......................11 William St., New York City
STEPHENS, JAMES ....Ishpeming, Mich.
STEVENS, THOMAS J............................Ironwood, Mich.
STOEK, H. H...................University of Illinois, Urbana, Ills.
STRONG, CLARENCE G.........................Cincinnati, Ohio
SUESS, JOSEPH E................................Negaunee, Mich.
SULLIVAN, A. J..................................Chisholm, Minn.
SUTHERLAND, D. E...............................Ironwood, Mich.
SWIFT, GEORGE D...................................Duluth, Minn.
SWIFT, PAUL D...................................Houghton, Mich.

TALBOYS, HENRY H.........717 Providence Bldg., Duluth, Minn.
TANCIG, A..Hibbing, Minn.
TAPPAN, WILLIAM M...........................Hibbing, Minn.
TARR, S. W.......................610 Wolvin Bldg., Duluth, Minn.
TAYLOR, JAMES HALL....................Box 485, Chicago, Ills.
THIEMAN EDWARD ....Florence, Wis.
THOMAS, KIRBY ....505 Pearl St., New York City
THOMS, REUBEN KNIGHT...............................Ely, Minn.
THOMPSON, CARMI A.......Room 222, G. N. Bldg., St. Paul, Minn.
THOMPSON, G H...................................Hibbing, Minn.
THOMPSON, HENRY S.............................Beacon, Mich.
THOMPSON, JAMES R..........................Ishpeming, Mich.
TOWNSEND, C. V. R............................Negaunee, Mich.
TRAVER, WILBER H..................Fisher Bldg., Chicago, Ills.
TREBILCOCK, JOHN ....Ishpeming, Mich.
TREBILCOCK, WILLIAM ....North Freedom, Wis.
TREPANIER, HENRY ....Iron Mountain, Mich.
TREZONA, CHARLES ....Ely, Minn.
TREVARROW, HENRY ....Negaunee, Mich.
TREVARTHAN, W. J..............................Bessemer, Mich.
TRIPP, CHESTER D........1515 Corn Exchange Bldg., Chicago, Ills.
TRUDGEON, JOHN ....Wakefield, Mich.
TUBBY, CHARLES W.........703 Commerce Bldg., St. Paul, Minn.
TUFTS, JOHN W.................900 Hackett Ave., Milwaukee, Wis.
TURNER, CHAS. N............Colby-Abbott Bldg., Milwaukee, Wis.

UHLER, FRED WALTER..................................Buhl, Minn.
ULRICH, WILLIAM F............................Chisholm, Minn.
UREN, WILLIAM J.............124 College Ave., Houghton, Mich.

VALLAT, BENJAMIN W..............................Ironwood, Mich.
VAN DYKE, W. D..................................Milwaukee, Wis.
VANDEVENTER, VIVIAN H.........................Ishpeming, Mich.
VAN EVERA, JOHN R.............................Marquette, Mich.
VAN EVERA, WILBUR ....Virginia, Minn.
VAN MATER, J. A.........................55 Wall St., New York City
VAN ORDEN, F. L.................................Houghton, Mich.
VILAS, P. M............425 New York Life Bldg., Minneapolis, Minn.
VILAS, ROYAL L..................................Ishpeming, Mich.
VIVIAN, JAMES G.................909 Alworth Bldg., Duluth, Minn.
VOGEL, F. A..........................25 Broad St., New York City

WADE, JEPTHA H.....................Wade Bldg., Cleveland, Ohio
WAGNER, JOHN M..................................Houghton, Mich.
WALKER, ROBERT S.................Fidelity Bldg., Duluth, Minn.
WALKER, ELTON WILLARD ....Mass, Mich.
WALL, JAMES S..................................Iron River, Mich.
WALLACE, W. R...................................Houghton, Mich.
WALLACE GEORGE ....Marquette, Mich.
WARE, JOHN FRANKLIN.....Forest and Five Oaks Ave., Dayton, O.
WARE, FRED ....Negaunee, Mich.
WARREN, O. B......................................Hibbing, Minn.
WARRINER, S. D...............................Wilkesbarre, Pa.
WATSON, CHARLES H.........................Crystal Falls, Mich.
WEARNE, WILLIAM ....Hibbing, Minn.
WEBB, FRANCIS J. ....812 Fidelity Bldg., Duluth, Minn.
WEBB, WALTER M...................................Gilbert, Minn.
WELLS, PEARSON ....Ironwood, Mich.
WENGLER, MATT P..........1055 Cambridge Ave., Milwaukee, Wis.
WESSINGER, W. E.................610 Wolvin Bldg., Duluth, Minn.
WEST, WILLIAM J...................................Hibbing, Minn.
WHEELWRIGHT, O. W...............................Florence, Wis.
WHITE, WILLIAM ....Virginia, Minn.
WHITE, EDWIN E..................................Ishpeming, Mich.
WHITE, J. W.................1905 E. Superior St., Duluth, Minn.
WHITEHEAD, R. G....................................Amasa, Mich.
WHITESIDE, DR. JOHN W..........................Ironwood, Mich.
WILCOX, LEE L.....................................Gilbert, Minn.
WILLARD, PAUL D...................................Hibbing, Minn.
WILLEY, NORMAN W. ....Hibbing, Minn.
WILKINS, WILLIAM ....Detroit, Mich.
WILLIAMS, THOMAS H...................................Ely, Minn.
WILLIAMS, PERCIVAL S..............................Ramsay, Mich.
WILLIAMS, DEAN R..........1213 Majestic Bldg, Milwaukee, Wis.
WILSON, EUGENE B.................................Scranton, Pa.
WILSON, ARTHUR O..................................Hibbing, Minn.
WINCHELL, HORACE V........505 Palace Bldg., Minneapolis, Minn.

WINTER, JOSEPH H. .... Negaunee, Mich.
WITHERBEE, F. S. .... Port Henry, New York
WOODBRIDGE, DWIGHT E. .... Sellwood Bldg., Duluth, Minn.
WOODWORTH, G. L. .... Iron River, Mich.
WOODWORTH, R. B. .... 427 Carnegie Bldg., Pittsburg, Pa.
WOOLF, PERCIVAL J. .... Minneapolis, Minn.
WORDEN, EUCLID P. .... 571 Summit Ave., Milwaukee, Wis.

YATES, WILLIAM H. .... Negaunee, Mich.
YOUNG, H. OLIN .... Ishpeming, Mich.
YOUNGS, FRANK W. .... Iron River, Mich.
YOUNGS, G. W. .... Iron River, Mich.
YUNGBLUTH, A. J. .... Ishpeming, Mich.

ZAPFFE, CARL .... 213 Citizens State Bank Bldg., Brainerd, Minn.
ZIMMERMAN, WALTER G. .... Duluth, Minn.

DECEASED MEMBERS.

ARMSTRONG, J. F........1898
BAWDEN, JOHN T........1899
BENNETT, JAMES H.........
BIRKHEAD, LENNOX 1911
BROOKS, T. B............1902
BULLOCK, M. C..........1899
COWLING, NICHOLAS ...1910
CONRO, ALBERT 1901
CLEAVES, WILL S.......1910
CHADBOURNE, T. L......1911
CUMMINGS, GEO. P......1911
DANIELS, JOHN 1898
DICKENSON, W. E.......1899
DOWNING, W. H..........1906
DUNCAN, JOHN 1904
DUNSTON, THOMAS B.......
GARBERSON, W. R.......1908
HALL, CHAS. H...........1910
HARPER, GEORGE V.....1905
HASELTON, H. S.........1911
HAYDEN, GEORGE 1902
HINTON, FRANCIS 1896
HOLLAND, JAMES 1900
HOLLEY, S. H...........1899
HOUGHTON, JACOB 1903
HYDE, WELCOME ....
JEFFREY, WALTER M.. .1906
JOCHIM, JOHN W........1905
KRUSE, JOHN C..........1907
LUSTFIELD, A............1904
LYON, JOHN B...........1900
MAAS, WM. J.............1911
MARR, GEORGE A........1905
MILLER, A. M............1912
MITCHELL, SAMUEL 1908
M'VICHIE, D..............1906
NINESE, EDMUND 1909
OLIVER, HENRY W......1904
PEARCE, H. A............1905
PERSONS, GEORGE R....1908
POPE, GRAHAM 1912
ROBERTS, E. S..............
ROWE, JAMES 1911
RYAN, EDWARD 1901
SHEPHARD, AMOS 1905
STANLAKE, JAMES 1910
STANTON, JOHN 1906
STEVENS, HORACE J....1912
STURTEVANT, H. B......1910
THOMAS, HENRY 1905
TOBIN, JAMES 1912
TREVARTHEN, G. C......1898
TRUSCOTT, HENRY 1910
VAN DYKE, JOHN H.....1906
WALLACE, JOHN 1898
WHITE, PETER 1908
WHITNEY, J. D...........1894
WILLIAMS, W. H.........1897

LIST OF DECEASED MEMBERS REPORTED SINCE THE ANNUAL MEETING OF 1912.

CLARK, H. S. ....
KOENIG, GEORGE A..........................January 14th, 1913
THOMAS, WILLIAM ....
M'NAMARA, T. ....October 26th, 1912
MINER, A. B..................................January 12th, 1913
DEACON, JOHN ....May 15, 1913

LIST OF PAPERS PUBLISHED IN PRECEDING VOLUMES.

1893—Vol. I.

1894—Vol. II.

1895—Vol. III.

1896—Vol. IV.

1898—Vol. V.

1900—Vol. VI.

1901—Vol. VII.

1902—Vol. VIII.

1903—Vol. IX.

1904—Vol. X.

1905—Vol. XI.

1906—Vol. XII.

1908—Vol. XIII.

1909—XIV.

1910—Vol. XV.

1911—Vol. XVI.

1912—Vol. XVII.

LIST OF MEETINGS OF THE INSTITUTE AND THEIR LOCALITIES FROM ITS ORGANIZATION TO AUGUST, 1913.

No.	Place.	Date.	Proceedings.
1	Iron Mountain, Mich	March 22-23, 1893	Vol. I
2	Houghton, Mich	March 7-9, 1894	Vol. II
3	Mesabi and Vermilion Ranges	March 6-8, 1895	Vol. III
4	Ishpeming, Mich	August 18-20, 1896	Vol. IV
5	Ironwood, Mich	August 16-18, 1898	Vol. V
6	Iron Mountain, Mich	February 6-8, 1900	Vol. VI
7	Houghton, Mich	March 5-9, 1901	Vol. VII
8	Mesabi and Vermilion Ranges	August 19-21, 1902	Vol. VIII
9	Ishpeming, Mich	August 18-20, 1903	Vol. IX
10	Ironwood, Mich	August 16-18, 1904	Vol. X
11	Iron Mountain, Mich	October 17-19, 1905	Vol. XI
12	Houghton, Mich	August 8-10, 1906	Vol. XII
13	Mesabi and Vermilion Ranges	June 24-27, 1908	Vol. XIII
14	Ishpeming, Mich	August 25-27, 1909	Vol. XIV
15	Ironwood, Mich	August 24-26, 1910	Vol. XV
16	Crystal Falls, Mich	August 22-24, 1911	Vol. XVI
17	Houghton, Mich	August 28-30, 1912	Vol. XVII
18	Mesabi Range	August 26-30, 1913	Vol. XVIII

Note—No meetings were held in 1897, 1899 and 1907.

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Creitter; 9 C. M. 1
22 Joseph Fay; 23
J. H. Rough; 37 D
Pascoe; 51 J. M. C
54 C. J. Stakel; 65
rtling; 81 C E. E
illiamson; 102 C. 1
chleau; 118 A. J.
0 Roger Woodbrid
A. T. Gordon; 145
Tom Kitts; 163 I
179 R. L. Vilas; 1
od Carr; 203 O. J
217 W. C. Rowe;
nstone.

ee and dues as provided by Section V.

ach person proposed as an honorary member shall be recommded by at least ten members, approved by the Council, and electby ballot at a regular meeting, (or by ballot at any time conductthrough the mail, as the Council may prescribe), on receiving -tenths of the votes cast.

IV.

WITHDRAWAL FROM MEMBERSHIP.

Upon the recommendation of the Council, any member may be cken from the list and denied the privilege of membership, by

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RULES OF THE INSTITUTE.

I.

OBJECTS.

The objects of the Lake Superior Mining Institute are to promote the arts and sciences connected with the economical production of the useful minerals and metals in the Lake Superior region, and the welfare of those employed in these industries, by means of meetings of social intercourse, by excursions, and by the reading and discussion of practical and professional papers, and to circulate, by means of publications among its members the information thus obtained.

II.

MEMBERSHIP.

Any person interested in the objects of the Institute is eligible for membership.

Honorary members not exceeding ten in number, may be admitted to all the privileges of regular members, except to vote. They must be persons eminent in mining or sciences relating thereto.

III.

ELECTION OF MEMBERS.

Each person desirous of becoming a member shall be proposed by at least three members approved by the Council, and elected by ballot at a regular meeting (or by ballot at any time conducted through the mail, as the Council may prescribe), upon receiving three-fourths of the votes cast. Application must be accompanied by fee and dues as provided by Section V.

Each person proposed as an honorary member shall be recommended by at least ten members, approved by the Council, and elected by ballot at a regular meeting, (or by ballot at any time conducted through the mail, as the Council may prescribe), on receiving nine-tenths of the votes cast.

IV.

WITHDRAWAL FROM MEMBERSHIP.

Upon the recommendation of the Council, any member may be stricken from the list and denied the privilege of membership, by

the vote of three-fourths of the members present at any regular meeting, due notice having been mailed in writing by the Secretary to him.

V.

DUES.

The membership fee shall be five dollars and the annual dues five dollars, and applications for membership must be accompanied by a remittance of ten dollars; five dollars for such membership fee and five dollars for dues for the first year. Honorary members shall not be liable to dues. Any member not in arrears may become a life member by the payment of fifty dollars at one time, and shall not be liable thereafter to annual dues. Any member in arrears may, at the discretion of the Council, be deprived of the receipt of publications or be stricken from the list of members when in arrears six months; Provided, That he may be restored to membership by the Council on the payment of all arrears, or by re-election after an interval of three years.

VI.

OFFICERS.

There shall be a President, five Vice Presidents, five Managers, a Secretary and a Treasurer, and these Officers shall constitute the Council.

VII.

TERM OF OFFICE.

The President, Secretary and Treasurer shall be elected for one year, and the Vice Presidents and Managers for two years, except that at the first election two Vice Presidents and three Managers shall be elected for only one year. No President, Vice President, or Manager shall be eligible for immediate re-election to the same office at the expiration of the term for which he was elected. The term of office shall continue until the adjournment of the meeting at which their successors are elected.

Vacancies in the Council, whether by death, resignation, or the failure for one year to attend the Council meetings, or to perform the duties of the office, shall be filled by the appointment of the Council, and any person so appointed shall hold office for the remainder of the term for which his predecessor was elected or appointed; Provided, That such appointment shall not render him ineligible at the next election.

VIII.

DUTIES OF OFFICERS.

All the affairs of the Institute shall be managed by the Council except the selection of the place of holding regular meetings.

The duties of all Officers shall be such as usually pertain to their offices, or may be delegated to them by the Council.

The Council may, in its discretion, require bonds to be given by the Treasurer, and may allow the Secretary such compensation for his services as they deem proper.

At each annual meeting the Council shall make a report of proceedings to the Institute, together with a financial statement.

Five members of the Council shall constitute a quorum; but the Council may appoint an executive committee, business may be transacted at a regularly called meeting of the Council, at which less than a quorum is present, subject to the approval of a majority of the Council, subsequently given in writing to the Secretary and recorded by him with the minutes.

There shall be a meeting of the Council at every regular meeting of the Institute and at such other times as they determine.

IX.

ELECTION OF OFFICERS.

Any five members not in arrears, may nominate and present to the Secretary over their signatures, at least thirty days before the annual meeting, the names of such candidates as they may select for offices falling under the rules. The Council, or a committee thereof duly authorized for the purpose, may also make similar nominations. The assent of the nominees shall have been secured in all cases.

No less than two weeks prior to the annual meeting, the Secretary shall mail to all members not in arrears a list of all nominations made and the number of officers to be voted for in the form of a letter ballot. Each member may vote either by striking from or adding to the names upon the list, leaving names not exceeding in number the officers to be elected, or by preparing a new list, signing the ballot with his name, and either mailing it to the Secretary, or presenting it in person at the annual meeting.

In case nominations are not made thirty days prior to the date of the annual meeting for all the offices becoming vacant under the rules, nominations for such offices may be made at the said meeting by five members. not in arrears, and an election held by a written or printed ballot.

The ballots in either case shall be received and examined by three tellers appointed at the annual meeting by the presiding officer; and the persons who shall have received the greatest number of votes for the several offices shall be declared elected. The ballot shall be destroyed, and a list of the elected officers, certified by the tellers, shall be preserved by the Secretary.

X.

MEETINGS.

The annual meeting of the Institute shall be held at such time as

may be designated by the Council. The Institute may at a regular meeting select the place for holding the next regular meeting. If no place is selected by the Institute it shall be done by the Council.

Special meetings may be called whenever the Council may see fit; and the Secretary shall call a special meeting at the written request of twenty or more members. No other business shall be transacted at a special meeting than that for which it was called.

Notices of all meetings shall be mailed to all members at least thirty days in advance, with a statement of the business to be transacted, papers to be read, topics for discussion and excursions proposed.

No vote shall be taken at any meeting on any question not pertaining to the business of conducting the Institute.

Every question that shall properly come before any meeting of the Institute, shall be decided, unless otherwise provided for in these rules, by the votes of a majority of the members then present.

Any member may introduce a stranger to any regular meeting; but the latter shall not take part in the proceedings without the consent of the meeting.

XI.

PAPERS AND PUBLICATIONS.

Any member may read a paper at any regular meeting of the Institute, provided the same shall have been submitted to and approved by the Council, or a committee duly authorized by it for that purpose prior to such meeting. All papers shall become the property of the Institute on their acceptance, and with the discussion thereon, shall subsequently be published for distribution. The number, form and distribution of all publications shall be under the control of the Council.

The Institute is not, as a body, responsible for the statements of facts or opinion advanced in papers or discussion at its meetings, and it is understood, that papers and discussions should not include personalities, or matters relating to politics, or purely to trade.

XII.

SPECIAL COMMITTEES.

The Council is authorized to appoint from time to time special committees to consider and report upon, to the Institute through the Council, such subjects as changes in mining laws, safety devices, the securing and editing of papers on mining methods, definition of mining terms, affiliations with other societies, and such other subjects as the Council shall deem it desirable to inquire into, such reports not to be binding on the Institute except action is taken by

the Institute in accordance with the rules, and the Council is authorized to expend not exceeding six hundred dollars in any one year to carry out the purpose of this section.

XIII.

AMENDMENTS.

These rules may be amended by a two-thirds vote taken by letter ballot in the same manner as is provided for the election of officers by letter ballot; Provided, That written notice of the proposed amendment shall have been given at a previous meeting.

EXCURSIONS.

TUESDAY, AUGUST 26TH, 1913.

The Lake Superior Mining Institute held its Eighteenth Annual Meeting on the Missabe Range, the members assembling at Duluth, most of them arriving there on the morning trains. Headquarters were established at the Spalding Hotel where members and their guests secured tickets and reservations for the trip over the range. The morning was very pleasantly spent in renewing old acquaintances, meeting new ones, and expressions of good fellowship.

The party left Duluth at 2 o'clock on the Steamer "Columbia" to inspect the plant of the Minnesota Steel Company, a subsidiary of the United States Steel Corporation. They found the plant still in the process of construction upon a tract of 1,500 acres with a water frontage of more than two miles along the St. Louis river. It is about nine miles from the center of Duluth. The plant when completed and equipped will, it is said, be the best plant among the many operated by the Steel Corporation. The buildings are of steel frames, enclosed with two-piece concrete blocks, making them absolutely fire-proof. There will be two blast furnaces of 500 tons capacity each, and ten open-hearth furnaces, also ninety Koppers type by-product coke ovens; one 40-inch reversing blooming mill; one 28-inch finishing mill; one 16-inch continuous roughing train. The power is of 10,000 k. w. capacity; five blowing engines, driven by gas, and of 20,000 cubic feet capacity each, and a pumping station of 40,000 gallons daily capacity. There will be also machine and structural shops sufficient to supply the needs of the company. The company is also erecting 175 houses containing

350 apartments for the accommodation of their men and their families. They contemplate building a cement plant, of 4,000 barrels per day capacity, in the near future.

After securing much valuable information from the inspection of this plant the party returned to Duluth, arriving there shortly before 6 o'clock. The evening was very enjoyably spent as guests of the various clubs. The party left in three special trains over the Duluth & Iron Range Railroad at midnight. One of these luxurious trains was composed of ten sleeping and dining cars, the other two of fifteen private cars.

WEDNESDAY, AUGUST 27TH, 1913.

The first stop was made at Biwabik, which is located on the eastern end of the range. A very interesting inspection of the Biwabik mine was made. This property was the second on the range to mine iron ore. It was opened in 1891, one year after the discovery at Mountain Iron. A part of the ore mined there is of a very hard grade and has to be crushed. The crusher is of the gyratory type. Its capacity is 1,000 tons per hour. It is said to be the largest crusher of this type, having an opening of 48 inches.

The party left Biwabik, in seventy automobiles, for Virginia, where the afternoon and night were spent sight-seeing and visiting. On the road a visit was paid to the Genoa mine, near Eveleth, one of the deep pits of the range. It is so deep that it is no longer profitable to work with steam shovels. Most of the ore is now taken to the surface through two shafts. A stop was also made at the Leonidas. Here many went underground for the purpose of inspecting the concrete pumping station and new pumps. This is the deepest property on the range. They are now mining at a depth of 480 feet.

A very enjoyable dinner of the New England style was served by the people of Eveleth at the new Glode Hotel. After dinner the Norman, Union, and Commodore mines of Virginia were inspected. It is interesting to note that the Norman is the deepest pit on the range, so deep that the steam

shovel work has been abandoned. The pit is over 300 feet deep and, owing to the narrowness of the vein and the perpendicular walls of rock, mining operations have been carried on with much difficulty.

The party was next taken to the modern equipped saw mill plant of the Virginia & Rainy Lake Company. This plant consists of three large mills, all within the city limits of Virginia. They have a combined capacity of one million feet of lumber per day. It requires a force of about 1,400 men to operate these mills. The company also has a large force of men employed in the woods getting out logs to supply the mills.

Some of the company who were especially interested in this feature of Missabe mine operations visited the drying plant at the Brunt mine. The ore is brought from the open pit a mile distant and run through the dryers. This process reduces the moisture from 18 to 8 per cent. The plant consists of four dryers and the estimated output for 1913 is 200,000 tons. This plant is operated by the M. A. Hanna Company. A short visit to the concentrating plant at the Madrid mine, of the A. B. Coates group, was made. This plant is described by Benedict Crowell in a paper which is printed in this volume. A map and description of the Commodore mine of the Corrigan, McKinney Company, is published in connection with the paper on "Mining Methods on the Missabe Range."

Some other properties were visited during the afternoon, and at 4 o'clock a game of base ball between the Virginia and Range teams was greatly enjoyed. A splendid dinner was served by the mining men of Virginia at the new home of the Elks Lodge of that city. The dinner was followed by an excellent musical program. A business session was held in the evening in the high school building.

Thursday, August 28th, 1913.

The party left Virginia, at 9 o'clock, for Chisholm, where luncheon was served by the citizens at Bergeron Hall. Stops

were made en route at the Mountain Iron, Shenango, and Monroe properties. As mentioned above Mountain Iron is the place where the first iron ore on the Missabe Range was discovered. This big pit has shipped over seventeen million tons of iron ore. The Shenango is one of the big open pit mines of the Missabe. It has been worked to considerable depth. The Monroe is not operating. The mine is completely stripped, but no ore has been mined since 1909. The property adjoining the Monroe is now being stripped by the Great Northern Railroad interests, who contemplate operating the mines on the Hill Lands, now under lease to the Oliver Iron Mining company.

The party moved from Chisholm to Hibbing, which is only a few miles, stopping on the way at the Leonard mine. Here the entertainment provided a visit to the Fair grounds where the St. Louis County Fair was being held. Everybody greatly enjoyed the horse races in spite of the fact that recent rains had made the track exceedingly heavy. The exhibit of agricultural produce was exceptionally creditable for such a new country. The Fair was well patronized by people from the adjoining towns and everybody seemed to be having a good time.

The evening entertainment at Hibbing was given at the Armory. The several city clubs held open-house and the evening was very enjoyably spent.

Friday, August 29th, 1913.

About 9 o'clock in the morning the party embarked in flat cars provided with seats, and were taken into the open pits of the Mahoning, Hull-Rust, Burt-Pool, and Sellers. These mines are located in the city of Hibbing. Mining is being done very close to the city streets in several places, and before many years a part of the city will have to be moved to make way for mining. The Hull-Rust is the largest iron property in the world. It has shipped over 20,000,000 tons of ore up to the present time. The mine was first opened in 1896, and there are many million tons now in sight so that

mining will be carried on there for many years to come. The extent of the ore body at this point is given as 5 miles in length by 3 or 4 thousand feet in width. A visit was also made to the Buffalo & Susquehanna property. More than 140 feet of over-burden had to be removed before the ore could be mined and shipping commenced. The work was done in record time because of the character of the ground. They found the ore to a depth of 700 feet.

Special trains departed from Hibbing at 10:30 o'clock for Coleraine, on the western end of the Range, where the night was spent and a business meeting held. Stops were made at the Stephenson, Hawkins, Crosby, Hill, Holman, and Canisteo mines. All of these mines do open pit mining although some are also operating with shafts. The Holman and Canisteo mines are very near to Coleraine. Coleraine is one of the best laid-out and finest mining locations in the country. Its location is almost ideal, being on the hills on the shore of Trout Lake.

SATURDAY, AUGUST, 30TH, 1913.

After breakfast Saturday morning the Oliver Iron Mining Company's concentrating plant was visited. Here we saw how the ores from the pits are freed of sand. A large portion of the ore on the Western Missabe range contains a great quantity of sand. This worthless material is washed out in the concentrating plant, thereby bringing the ore to a merchantable grade. The Coleraine plant has a capacity of 20,000 tons daily. This is composed of five units of 4,000 tons each. A paper by John Uno Sebenius, chief engineer for the Oliver Iron Mining Company, describing this plant, appears in another part of this publication.

The inspection of the concentrating plant ended the pleasurable and instructive inspection of the wonderful Missabe Range, so the special trains were again boarded and the party began the return to Duluth, where they arrived shortly after the noon hour. Most of those who had enjoyed the trip left on evening trains for their homes, all loud in their

praises of the entertainment accorded to them by the good people of the Missabe Range. How could they feel otherwise? Brass bands were in atendance in all towns visited and every host seemed to endeavor to outdo every other in the cordial sincerity of their greetings. It is always pleasant to meet old acquaintances and fellow workers of days that are gone. Many of the residents of the newer towns of the Missabe Range were formerly residents and workers in the older fields. There was evidence of progress and improvement on every hand which was remarked by all who had visited the Range on former trips of the Institute. The attendance numbered more than 300.

A booklet, published by the General Committee, contains many views and much interesting information, compiled and arranged by W. W. J. Croze, mining engineer, Duluth, and is published as an appendix to this volume.

BUSINESS SESSIONS.

The first business meeting was held on Wednesday evening at 8:30, at the Roosevelt High school, in the City of Virginia, President Pentecost Mitchell presiding. Mr. Mitchell, on behalf of the membership from the Minnesota ranges, extended a cordial welcome to the members and guests present.

Papers were presented in the following order:

*Report of Committee on the Practice for the Prevention of Accidents, was, in the absence of the members, read by title. It presented the report of the two meetings held by the Committee, on March 26th and July 22nd, 1913. The Committee especially advises the adoption of the classification of accidents as used by the United States Bureau of Mines in order that all reports may be uniform. Discussion of this paper should be presented at the next meeting.

The following papers, in the absence of the authors, were read by title:

*Sanitation for Mine Locations, by W. H. Moulton, Ishpeming, Mich.

*Winona Stamp Mill, by R. R. Seeber, Winona, Mich.

*Mining Methods on the Missabe Range, by Willard Bayliss J. S. Lutes and E. D. McNeil, Committee was presented in oral abstract by Messrs. Bayliss and McNeil.

*What Our Neighbors Can Do In Mining Iron Ore, by Dwight E. Woodbridge, Duluth, Minn., was read by the author.

*Safety in the Mines of the Lake Superior Iron Ranges, by Edwin Higgins, Ironwood, Mich., was presented in oral abstract. Discussion is published following paper.

This concluded the reading of papers for the evening.

The President here introduced Charles E. VanBarneveld, chief of the department of Mines and Metallurgy of the Panama-Pacific International Exposition, 1915, who addressed the meeting as follows:

Someone has aptly called the Panama Canal "the Greatest Liberty ever taken with nature." The successful completion of this project is due to American enterprise and American engineering skill. The nation is justly proud of this achievement and proposes to celebrate it by holding an International Exposition in San Francisco in 1915. I wish to lay special emphasis on the word **International**. Because of its location, the Exposition is often spoken of and more often thought of as California's Exposition. While the majority wish it success and hope to take it in, a great many people do not seem to realize that practically everyone who occupies a position of any responsibility in American professional and industrial life owes some direct thought and attention to this Exposition **now**.

In a sense California is the host. In a larger sense, however, the Nation is the host. The Nation has issued the call and has invited world-wide participation. Canadian, Australian, Asiatic and South American participation are assured on a large scale. The same may be said of Europe. While two important European Nations have officially declined to participate for the present, there is every reason to feel assured that they will ultimately be well represented.

The citizens of California in preparing for this Exposition have raised 17½ million dollars This sum is being wisely expended in preparation of the site, in the erection and equipment of the Exposition Palaces and in the maintenance of the Division of Exhibits. The Director of Exhibits and his staff will be in readiness to advise with you, to receive and intelligently display the Nation's contribu-

*Papers distributed in printed form.

tions towards this celebration. Beyond that, it must be clear to you that the responsibility for a successful Exposition lies with professional and industrial America.

This Exposition will be a record of the history of the world's progress in all the arts and industries. Its exhibits, gathered from all over the world, will tell the casual observer, the student, the thinker by object-lessons instead of by words, what mankind is, does, and seeks to do. It will be a living picture illustrating and interpreting the cold and bare statistics which, without such interpretation, are incomprehensible and meaningless to the average mind. It is therefore the privilege and duty of each industry to properly represent its activities. Each industry being in turn the host to all others.

The Division of Exhibits is organized into eleven departments, one of which is Mines & Metallurgy. The Palace of Mines is a beautiful building, well located and has about 200,000 square feet of floor space. In addition to exhibiting the World's Natural Mineral Resources, including the Metallics and Non-Metallics, we hope to fully illustrate the technique and the industrial side of Mining and Metallurgy. This can only be done through the hearty co-operation of the profession and the industry.

It has been said that mining operations do not lead themselves readily to exhibition and that the legitimate mine-operator has little commercial incentive to exhibit because he has nothing to advertise, nothing to sell! Fortunately, the mining industry is, in the main, in the hands of public-spirited men, accustomed to taking a large view of things, men who will not allow the lack of commercial incentive, the lack of apparent direct individual benefit, to outweigh the decided indirect, collective benefits to be derived from the right sort of publicity. We hear much of the decadence of prospecting and mining, of the lack of security and stability of mining investments. The miner has suffered greatly from misunderstanding, from public ignorance, and above all from persistent misrepresentation. We all recognize in a general way, the importance of education; it is the greatest remedy for prejudice, superstition, and ignorance; it makes for greater all-around efficiency. A well planned exposition is of incalculable value as an educator of the public mind and no industry is in greater need of this service today than mining. Many important questions in which the miner is vitally interested are pressing for settlement. The public is taking an increasingly active part in forcing these settlements. When not blinded by prejudice and ignorance, the public is essentially fair-minded; it only needs to be educated. You have before you now an opportunity which probably will not recur for a decade to give the public an insight into the importance, the stability, and solidarity of your industry, its legitimate speculative and investment features, your need of capital, of fair treatment, of wise legislation, of public support and co-operation.

Every mining man should see in this Exposition an opportunity for some broadcast sowing. The higher he has risen in his profession, the more important the enterprise he owns, directs or is associated with, the greater will his opportunity be. To approve the sentiment that the industry should be properly represented is only the first step. While the result will be collective, the responsibility is individual. If each man will ask himself, What can I do individually—What can I do to interest my company, my clients—What can I do to interest my superiors, my subordinates, to interest machinery men and those interested in special processes; and having asked and thought, will then set about doing it, we will have a mining and metallurgical exhibit worthy of the industry.

The Lake Superior Districts are justly famed for their copper and iron ore production. From the standpoint of tonnage, scale of operation and engineering practice, this is the iron mining center of the world. The Lake Superior miner of the past generation was the originator and you of the present generation are the perfectors of mining methods which are copied all over the country. The Exposition therefore makes a direct appeal to your individual pride, to your pride of industry, to your state and national pride—in a word, to the best that is in you; your patriotism.

Get together on this proposition, gentlemen, and give us an Exhibit worthy of your branch of the industry which more than any has advanced the settlement, the upbuilding and civilization of this country.

The next order of business was appointing the various special committees. On motions duly made, seconded and carried, the President appointed the following committees, to report at the business session on Friday evening.

COMMITTEE ON NOMINATIONS—Mark Elliott, Virginia, Minn.; Wm. J. Richards, Crystal Falls, Mich.; Peter W. Pascoe, Republic, Mich.; Andre Formis, Ojibway, Mich.; L. M. Hardenburgh, Hurley, Wis.

AUDITING COMMITTEE—Frank B. Goodman, Hurley, Wis.; Max H. Barber, Nashwauk, Minn.; Charles Grabowsky, Virginia, Minn.

COMMITTEE ON RESOLUTIONS—John H. Hearding, Duluth, Minn.; George H. Abeel, Ironwood, Mich.; Wm. H. Johnston, Ishpeming, Mich.

An adjournment was then taken to Friday evening at 8:30 o'clock, at the Village Hall, Coleraine.

BUSINESS SESSION FRIDAY EVENING.

At 8:30 the final business meeting was held. Owing to the inability of President Mitchell to be present, Vice President George H. Abeel, presided. The presentation of papers was continued, and were taken up in the following order:

The following papers were read by title:

*Relining No. 2 Hamilton Shaft with Reinforced Dividers, End Plates and Poured Concrete Walls, by S. W. Tarr, Duluth, Minn.

*Suggestions on the Application of Efficiency Methods to Mining, by C. M. Leonard, Gwinn, Mich.

*The Application of Mining Machines to Underground Mining on the Missabe Range, by H. E. Martin and W. J. Kaiser, Hibbing, Minn.

*Mine Laws, Special Rules and the Prevention of Accidents, by E. B. Wilson, Scranton, Pa. Discussion is published with the paper.

*Concentrating at the Madrid Mine, by Benedict Crowell, Cleveland, Ohio.

Wash Ores in Western Missabe and the Coleraine Washing Plant, by John Uno Sebenius, Duluth, Minn.

Electricity, by William Kelly, Vulcan, Mich. (Title not final.)

Hoist Efficiency, by Frank H. Armstrong, Vulcan, Mich. (Title not final.)

Dry House at East Vulcan Mine, Penn Iron Mining Co., by Floyd L. Burr, Vulcan, Mich.

This completed the reading of Papers and the report of the Council was then presented.

*Papers distributed in printed form

REPORT OF THE COUNCIL.

Secretary's report of Receipts and Disbursements from August 22nd, 1912 to August 18th, 1913.

RECEIPTS.

Cash on hand August 22nd, 1912......				$5,994 58
Entrance fees for 1912		$ 330 00		
Dues for 1912		2,210 00		
Back dues, 1909	$ 25 00			
Back dues, 1910	70 00			
Back dues, 1911	210 00	305 00		
Advance dues for 1913		55 00		
Sale of Proceedings		31 25		
Proposals for membership		30 00		
Institute pin		4 00		
Houghton meeting proportion of program..............		127 22		
Total			$3,092 47	
Interest on deposit			205 53	
Total receipts				3,298 00
Grand total				$9,292 00

DISBURSEMENTS.

Stationery and printing	$ 95 00		
Postage	139 06		
Freight and express	23 90		
Exchange	2 15		
Telephone and telegraphing	4 74		
Secretary's salary	750 00		
Stenographic work	60 00		
Total		$1,075 59	
Publishing Proceedings Vol. XVI	1,007 98		
Photographs, maps, etc.	131 31		
Advance papers 1912	191 75		
Programs, etc., 1912	170 72		
Advance papers, 1913, (cuts)	52 37		
Expense Houghton meetings, rent and stenographer	33 50		
Badges for meeting, 1912	81 25		
Committee meetings, traveling expenses	51 96		
Total		$1,720 84	
Total disbursements			2,796 43
Cash on hand August 18th, 1913......			6,496 15
Grand total			$9,292 58

MEMBERSHIP.

	1913	1912	1911
Total	518	486	517
Members in good standing	483	437	467
Honorary members	4	4	4
Life members	2	2	2
Members in arrears (2 years)	29	43	44
New members admitted, 1912	71	31	46
New members not qualified	5	4	3
New members added	66	27	43

TREASURER'S REPORT.

Treasurer's Report from August 26th, 1912, to August 18th, 1913:

Cash on hand August 26th, 1912	$5,994.58	
Received from secretary	3,062.47	
Received interest on deposits	205.53	
Paid drafts issued by secretary		$2,796.43
Cash on hand August 18th, 1913		6,466.15
Totals	$9,262.58	$9,262.58

Summary of cash on hand:

As per treasurer's report	$6,466.15
In hands of secretary	30.00
Total as per secretary's report	$6,496.15

The following standing committees were appointed by the Council for the ensuing year:

"PRACTICE FOR THE PREVENTION OF ACCIDENTS."

(Committee to consist of five members.)

C. E. Lawrence, Palatka, Mich., Chairman; D. E. Sutherland, Iron Mountain, Mich.; Wm. Conibear, Ishpeming, Mich.; W. H. Schacht, Painesdale, Mich.; M. H. Godfrey, Virginia, Minn.

"CARE AND HANDLING OF HOISTING ROPES."

(Committee to consist of five members.)

W. A. Cole, Ironwood, Mich., Chairman; O. D. McClure, Ishpeming, Mich.; J. S. Jacka, Crystal Falls, Mich.; W. J. Richards, Painesdale, Mich.; A. Tancig, Hibbing, Minn.

"PAPERS AND PUBLICATIONS."

(Committee to consist of five members.)

Wm. Kelly, Vulcan, Mich., Chairman; J. H. Hearding, Duluth, Minn.; F. W. McNair, Houghton, Mich.; J. E. Jopling, Ishpeming, Mich.; P. S. Williams, Ramsay, Mich.

"BUREAU OF MINES."

(Committee to consist of three members.)

M. M. Duncan, Ishpeming, Mich., Chairman; J. B. Cooper, Hubbell, Mich,; A. J. Yungbluth, Secretary, Ishpeming, Mich.

"BIOGRAPHY."

(Committee to consist of five members.)

J. H. Hearding, Duluth, Minn., Chairman; J. B. Cooper, Hubbell, Mich.; R. A. Douglas, Ironwood, Mich.; M. B. McGee, Crystal Falls Mich.; W. H. Newett, Ishpeming, Mich.

"MINING METHODS ON THE MARQUETTE RANGE."

(Committee to consist of three members to be appointed later.)

Committees to serve until their successors are appointed; each committee to have power to appoint sub-committees as may be deemed necessary.

The following letter and invitation was received from the Committee of Management of the International Engineering

Congress, to be held in San Francisco, Sept. 20th to 25th, 1915:

INTERNATIONAL ENGINEERING CONGRESS, 1915.

New York City, N. Y.

To the Secretary of
Lake Superior Mining Institute,
Ishpeming, Mich.

Dear Sir:

On behalf of the Committee of Management of the International Engineering Congress to be held in San Francisco in 1915, we have the honor to enclose herewith a most cordial invitation to the officers and members of your Society to attend and to participate in the proceedings of this Congress.

We would respectfully request that you transmit to your members the information contained in the preliminary announcement, which is also enclosed and which gives such outline of the Congress as can be furnished at the present time.

Further details relative to the Congress will be sent to you in the near future by the Secretary of the Committee of Management in San Francisco, and we would request that your reply to the invitation and to this, as well as to all future communications relative to the Congress, be addressed to the Executive Officers of the Committee of Management in San Francisco.

Very respectfully yours,

GEO. F. SWAIN, President.
CHAS. WARREN HUNT, Secretary.
American Society of Civil Engineers.

CHAS. F. RAND, President.
BRADLEY STOUGHTON, Secretary.
American Institute of Mining Engineers.

W. F. M. GOSS, President.
CALVIN W. RICE, Secretary.
The American Society of Mechanical Engineers.

RALPH DAVENPORT MERSHON, President.
F. L. HUTCHINSON, Secretary.
American Institute of Electrical Engineers.

ROBERT M. THOMPSON, President.
DANIEL H. COX, Secretary.
The Society of Naval Architects and Marine Engineers.

The American Society of Civil Engineers
The American Institute of Mining Engineers
The American Society of Mechanical Engineers
The American Institute of Electrical Engineers
and
The Society of Naval Architects and Marine Engineers
extend to the officers and members of
THE LAKE SUPERIOR MINING INSTITUTE
a most cordial invitation
to attend and to participate in the proceedings of
The International Engineering Congress
to be held in connection with
The Panama Pacific International Exposition
September twentieth to twenty-fifth
in the year one thousand nine hundred and fifteen
in San Francisco
California

The letter ballot on the resolution presented at the last annual meeting was referred to William Kelly and L. C. Brewer as tellers, who canvassed the vote and presented the following results:

Whole number votes cast, 200.

In favor of resolution, 200.

The resolution was accordingly adopted and added to the rules as Rule XII.

On motion the report of the Council was adopted.

The following proposals for membership have been approved by the Council:

Barr, J. Carroll, General Manager, Pittsburg Steel Ore Co., Crosby, Minn.

Batchelder, B. W., Superintendent Hawkins Mine, Nashwauk, Minn.

Bolles, Fred R., Assistant General Manager, Copper Range R. R., Houghton, Mich.

Burdorf, Harry A., Representative The Lunkenheimer Co., 2316 Garfield Ave., S. Minneapolis, Minn.

Bush, E. G., Diamond Drill Contractor, 909 Alworth Bldg., Duluth, Minn.

Caine, D. T., Local Superintendent, Republic Iron & Steel Co., Gilbert, Minn.

Cash, F. H., Local Superintendent, Republic Iron & Steel Co., Kinney, Minn.

Christianson, Peter, Professor of Metallurgy, School of Mines, University of Minnesota, Minneapolis, Minn.

Comstock, Henry, General Superintendent, Witherbee Sherman & Co., Mineville, New York.

Comstock, Ehling H., Professor Mechanics & Mathematics, School of Mines, University of Minnesota, Minneapolis, Minn.

Cook, Charles W., Instructor in Economic Geology, University of Michigan, Economics Bldg., Ann Arbor, Mich.

DeHaas, Nathan G., Wholesale Lumber, Marquette, Mich.

Diehl, Alfred S., Chief Engineer, Oliver Iron Mining Company, Coleraine, Minn.

Donahue, E. J. W., Secretary, Cuyuna-Duluth Iron Company, 416-17 Lonsdale Bldg., Duluth, Minn.

Dow, Herbert W., Sales Manager, Nordberg Mfg. Co., Milwaukee, Wis.

Drake, John M., Superintendent, Meridan Mine, Hibbing, Minn.

Eckstrom, Alexander, J., Mining Engineer, Keewatin, Minn.

Emmons, William H., Director, Minnesota Geological Survey, University of Minnesota, Minneapolis, Minn.

Flannigan, Thomas A., General Superintendent, Republic Iron & Steel Co., Gilbert, Minn.

Foote, George C., Resident Director, Witherbee Sherman & Co., Port Henry, New York.

Forbes, Guy R., Mining Engineer, 329 Hemlock St., Virginia, Minn.

Gaynor, William E., Manager Great Lakes Dredge & Dock Co., Duluth, Minn.

Halloday, Fred H., Superintendent Winston & Dear, Hibbing, Minn.

Hayden, J. Elzey, Mining Engineer, C. C. I. Co., Ishpeming, Mich.

Heim, Harry R., Salesman Westinghouse Elec. Co., 936 Metropolitan Life Bldg., Minneapolis, Minn.

Higgins, Edwin, Mining Engineer, care Bureau of Mines, Ironwood, Mich.

House, Allen C., care M. A. Hanna & Co., Cleveland, Ohio.

Jenks, C. O., General Superintendent, G. N. Ry., Superior, Wis.

Johnson, Harry O., Osterberg & Johnson, Diamond Drill Contractors, Virginia, Minn.

Johnson, Nels, Local Superintendent Republic Iron & Steel Co., Keewatin, Minn.

Johnstone, Orland W., Special Agent Soo Line, Duluth, Minn.

Kieren, Joseph, Master Mechanic, Republic Iron & Steel Co., Gilbert, Minn.

Kurtzman, P. L., Local Superintendent Republic Iron & Steel Co., McKinley, Minn.

Locker, W. H., Treasurer, Cuyuna-Duluth Iron Company, 416 Lonsdale Bldg., Duluth, Minn.

Middlemise Bruce A., Mine Superintendent, Hibbing, Minn.

Mitchell, Harold E., Leonidas, Oliver Iron Mining Company, Eveleth, Minn.

MacKillican, James A., Mining Engineer, Meridan Iron Co., Hibbing, Minn.

McRandle, William E. R., Superintendent Gale Mine, Bessemer, Mich.

Oberg, Anton C., Chief Engineer, Arthur Iron Mining Co., Hibbing, Minn.

Overpeck, Hollis W., Safety Inspector, Oliver Iron Mining Co., Virginia District, Virginia, Minn.

Pellenz, William F., Jr., Mining Superintendent, Carson Lake, Minn.

Penniman, Dwight C., Representative Central Electric Company, Clinton Hotel, Minneapolis, Minn.

Peterson, A. Y., Assistant General Superintendent, Oliver Iron Mining Co., Chisholm, Minn.

Philbin, Donald M., Charge Great Northern Iron Ore Properties, 408 Sellwood Bldg., Duluth, Minn.

Pursell, H. E., Sales Manager, Kewanee Boiler Co., Kewanee, Illinois.

Redner, A. E., Mining Captain, 216 Aurora Location, Ironwood, Mich.

Reifel, H. T., Superintendent La Rue Mine, Nashwauk, Minn.

Rouchleau, Louis, Mine Owner, West Hotel, Minneapolis, Minn.

Sellwood, R. M., Mining & Banking, Duluth, Minn.

Sheldon, Albert F., Garlock Packing Co., 112 N. Arch St., Marquette, Mich.

Shove, Brigham W., Agent C. N. W., Ry., Ironwood, Mich.

Silliman, Thomas, B., Mining Engineer, Coleraine, Minn.

Stephens, James, Mining Captain, North Lake, R. F. D., Ishpeming, Mich.

Sullivan, A. J., General Superintendent, Oliver Iron Mining Co., Chisholm, Minn.

Talboys, Henry H., Salesman, Ingersoll-Rand Drill Co., 717 Providence Bldg., Duluth, Minn.

Tappan, William M., Mining Superintendent, Hibbing, Minn.

Thomson, Carmi A., General Manager, Great Northern Iron Ore Properties, Room 222, G. N. Bldg., St. Paul, Minn.

Tubby, Charles, W., District Manager, International Steam Pump Co., 703 Commerce Bldg., St. Paul Minn.

Ulrich, William F., Chief Chemist Oliver Iron Mining Company, Chisholm, Minn.

Webb, Walter M., Safety Inspector, Republic Iron & Steel Co., Gilbert, Minn.

White, J. W., Sales Representative, The Jeffrey Mfg. Company, 1905 E. Superior St., Duluth, Minn.

Wilcox, Lee L., Chief Engineer, Republic Iron & Steel Co., Gilbert, Minn.

Willard, Paul D., Mining Engineer, Hibbing, Minn.

Williams, Dean R., Sales Agent, Williams & Wolff, 1213 Majestic Bldg., Milwaukee, Wis.

Wilson, Arthur O., Engineer Susquehanna Mine, Hibbing, Minn.

Woodbridge, Dwight E., Mining Engineer, Sellwood Bldg., Duluth, Minn.

Zimmerman, Walter G., Contracting Manager, American Bridge Co., Duluth, Minn.

On motion the Secretary was instructed to cast the ballot for the election of the applicants to membership.

The Auditing Committee then presented the following report:

Your Committee appointed to examine the books of the Secretary and Treasurer, beg leave to report that we have carefully examined same and find the receipts and expenditures shown therein to be in accordance with the statements of the Secretary and Treasurer for the fiscal year ending August 26th, 1913.

FRANK B. GOODMAN,
MAX H. BARBER,
CHAS. GRABOWSKY.

On motion the report of the Committee was adopted.

Report of Committee on Nominations.

Your Committee on nominations beg leave to submit the following names for officers of the Institute for terms specified:

For President (one year):
W. H. Johnston, Ishpeming, Mich.

For Vice Presidents (two years):
C. T. Kruse, Ishpeming, Mich.
Charles E. Lawrence, Palatka, Mich.
Luther C. Brewer, Ironwood, Mich.

For Managers (two years):
W. A. Siebenthal, Republic, Mich.
J. S. Lutes, Biwabik, Minn.

For Manager (one year, to fill vacancy):
S. R. Elliott, Negaunee, Mich.

For Treasurer (one year):
E. W. Hopkins, Commonwealth, Wis.

For Secretary (one year):
A. J. Yungbluth, Ishpeming, Mich.

MARK ELLIOTT,
W. J. RICHARDS,
PETER W. PASCOE,
ANDRE FORMIS,
L. M. HARDENBURGH,
Committee.

On motion the Secretary was instructed to cast the ballot for the election of the officers as submitted by the Committee.

On motion by Robert A. Douglass, the chair appointed the following Committee to escort the newly elected President to the platform: Robert A. Douglass and Pearson Wells. Mr. Johnston, upon being introduced, addressed the meeting as follows:

MR. JOHNSTON:

Mr. President and Members of the Institute: I appreciate what a very great honor you have conferred upon me, for I realize that it is a great honor to be President of the Institute. With this honor also goes a very great responsibility. I am more impressed with this responsibility after the fine program they have given us on this range. This meeting has been one of the most enjoyable I have ever attended. I think we have never had a greater number present than we have at this meeting. I should hesitate somewhat about accepting the responsibility, or the honor, if it were not for the fact that I know the members of the Institute stand so loyally by the President, and that they do everything in their power to make their meetings successful. I also know that I have some friends on the Marquette Range, members of the Institute, who will do everything in their power to make the meeting successful. I thank you for the honor.

The Committee on Resolutions presented the following report which was on motion adopted:

WHEREAS, The Virginia Club, Elks Club of Virginia, Algonquin Club of Hibbing, the Commercial Clubs of Duluth, and the entire Missabe Range have extended to this organization the facilities, conveniences, and what is much more, the greatest possible hospitality;

AND WHEREAS, Many of our friends and associates have contributed most kindly the use of their automobiles for our comfort and pleasure;

AND WHEREAS, Many of the church societies, other or-

ganizations and hotels, have given to us most plenteously of their food and good cheer;

AND WHEREAS, The Duluth Commercial Club contributed greatly to our enjoyment in the visit to the Minnesota Steel Plant by boat;

AND WHEREAS, The Duluth, Missabe and Northern Railway, the Duluth and Iron Range Railway, and the Great Northern Railway, and the Mining Companies, have made this trip possible through the use of their tracks and locomotives;

NOW THEREFOR, Be it resolved by the Lake Superior Mining Institute, and particularly by those members attending the 1913 meeting, they being well-fed, well-cared for, and widely travelled, that they extend to each and all of the above mentioned persons, individually and collectively, their sincere and hearty thanks.

J. H. HEARDING,
G. H. ABEEL,
W. H. JOHNSTON.
Committee.

This concluded the business sessions of the Eighteenth Annual meeting. The splendid list of papers prepared by the members will make this volume one of the most interesting yet published. The authors are fully entitled to the appreciation so freely expressed by the members for their efforts in contributing to the interest of the meeting.

Before the adjournment was taken the acting President announced that Mr. Sebenius would present some moving pictures of the various features connected with mining on the Missabe range. These consisted in views of the first steps in breaking roads and establishing diamond drilling, mining operations, loading and hauling ore to the docks and loading same into boats. Also the complete operation of getting out the timber used by mines, running logs and delivering same to the mines. This feature of the meeting was novel and most interesting.

The following is a partial list of those in attendance:

Abeel, G. H.....Ironwood, Mich.
Abeel, G. H. Jr..Ironwood, Mich.
Abell, O. J..........Chicago, Ills.
Allen, R. C. ......Lansing, Mich.
Armstrong, F. H. ..Vulcan, Mich.
Atkins, S. E.......Duluth, Minn.

Baldwin, C. K.......Chicago, Ill.
Barber, M. H...Nashwauk, Minn.
Barber, G. S....Bessemer, Mich.
Barney, Joseph .McKinley, Minn.
Barr, J. C........Riverton, Minn.
Batchelder, B. W. ....
.... Nashwauk, Minn.
Bayliss, Willard..Chisholm, Minn.
Benjamin, F. S....Duluth, Minn.
Bergeat, Prof. A...... ....
.... Koenigsberg, Germany
Bernhardt, F. J....Duluth, Minn.
Binney, Joseph..McKinley, Minn.
Blackburn, R. D..Hancock, Mich.
Bolles, F. R....Houghton, Mich.
Bond, Wm. ....Ironwood, Mich.
Bond, Thomas ..Ironwood, Mich.
Boss, C. M........Duluth, Minn.
Boyd, A. H.........Denver, Colo.
Brewer, L. C....Ironwood, Mich.
Brewer, Carl.Crystal Falls, Mich.
Brigham, E. D......Chicago, Ill.
Burdorf, H. A.Minneapolis, Minn.
Bush, E. C.........Duluth, Minn.

Caddy, Thomas...Hibbing, Minn.
Caine, D. S........Gilbert, Minn.
Campbell, D. H.Iron River, Mich.
Carbis, F..Iron Mountain, Mich.
Carbis, W. J.Iron Mountain, Mich.
Carmichael, Wm..Biwabik, Minn.
Carroll, J. R....Houghton, Mich.
Carroll, Philip..Houghton, Mich.
Cash, F. H.........Kinney, Minn.
Carlton, D. E.....Biwabik, Minn.
Chinn, W. P....McKinley, Minn.
Christianson, Peter, ...
.... Minneapolis, Minn.
Clifford, J. M....Escanaba, Mich.
Cole, C. D.....Ishpeming, Mich.
Cole, W. T. ....Ishpeming, Mich.
Cole, T. F.........Duluth, Minn.
Conibear, Wm..Ishpeming, Mich.

Comstock, E. H...............
.... Minneapolis, Minn.
Cook, C. W...Ann Arbor, Mich.
Congdon, W. B....Duluth, Minn.
Congdon, E. C....Duluth, Minn.
Cory, E. N......Negaunee, Mich.
Coventry, Frank..Hibbing, Minn.
Crosby, Geo. H....Duluth, Minn.

Desrochers, G. E.Houghton, Mich.
Diehl, A. S......Coleraine, Minn.
Donahue, E. J. W..Duluth, Minn.
Donovan, M. J...............
..........Iron Mountain, Mich.
Dormer, Geo. H...Eveleth, Minn.
Douglas, R A....Ironwood, Mich.
Dow, H. W......Milwaukee, Wis.
Dudley, H. C......Duluth, Minn.
Drake, J. M....Keewatin, Minn.

Eaton, Lucien..Ishpeming, Mich.
Eichenberger, R. W..Chicago, Ill.
Elliott, Mark.....Virginia, Minn.
Emmons, W. H...............
.... Minneapolis, Minn.
Erickson, Carl E.Ironwood, Mich.
Estep, H. Cole......Chicago, Ill.

Fairchild, D. L....Duluth, Minn.
Fay, Joseph ....Marquette, Mich.
Fay, A. H.....Washington, D. C.
Federstrom, J. A.Ironwood, Mich.
Felver, H. C....Houghton, Mich.
Fishwick, E. T..Milwaukee, Wis.
Flannigan, T. A...Gilbert, Minn.
Flodin, N. P....Marquette, Mich.
Forbes, G. R....Virginia, Minn.
Formis, A........Ojibway, Mich.

Gardner, O. D....Calumet, Mich.
Gaynor, W. E......Duluth, Minn.
Gish, J. R......Beaver Dam, Wis.
Godfrey, M. H....Virginia, Minn.
Goodman, F. B....Hurley, Wis.
Goodsell, B. W......Chicago, Ill.
Goudie, James ..Ironwood, Mich.
Grabowsky, Chas.Virginia, Minn.

Halloday, F. H....Hibbing, Minn.
Harris, S. T....Houghton, Mich.

Harrison, G. E...Hibbing, Minn.
Hart, Wm. C....Hibbing, Minn.
Harvey, W. H....Eveleth, Minn.
Hardenburgh, L. M...........
.... Ironwood, Mich.
Hastings, E. X..Green Bay, Wis.
Hayden, J. E..Ishpeming, Mich.
Hearding, J. H....Duluth, Minn.
Hearn, A. L......Virginia, Minn.
Heggaton, W. S.Negaunee, Mich.
Heim, H. R...Minneapolis, Minn.
Helps, S. E......Eveleth, Minn.
Hendrick, C. E..Virginia, Minn.
Heyn, Howard ..Ishpeming, Mich.
Higgins, Edwin..Ironwood, Mich.
Hill, Stacy H......Duluth, Minn.
Hingston, C. E....Duluth, Minn.
Hoatson, Thomas.Calumet, Mich.
Hocking, R. O....Hibbing, Minn.
Hodge, Richard ..Hibbing, Minn.
Holley, A. B....Virginia, Minn.
House, A. C....Cleveland, Ohio.
Huhtala, John....Palmer, Mich.
Hunner, Earl E....Duluth, Minn.
Huyck, Charles.......Clio, Mich.

Ireland, J. D......Duluth, Minn.

Jenks, C. O......Superior, Wis.
Johnson, E. F....Virginia, Minn.
Johnson, H. O..Virginia, Minn.
Johnston, W. H..Ishpeming, Mich.
Johnstone, O. W..Duluth, Minn.
Jory, Wm...........Gwinn, Mich.
Johnson, Nels.. Keewatin, Minn.

Kelly, William ....Vulcan, Mich.
Kennedy, C. S....Duluth, Minn.
Kieren, Jos. ......Gilbert, Minn.
Kitts, Thos......Hancock, Mich.
Kleffman, John....Hibbing, Minn.
Knight, R. C....Eveleth, Minn.
Kreiter, J. W.....Duluth, Minn.
Kurtzman, P. L..McKinley, Minn.

LaCroix, M. F..Ishpeming, Mich.
Lane, J. S......New York, N. Y.
Larochelle, L...Houghton, Mich.
LaRue, W. G......Duluth, Minn.
Latham, A. M....Virginia, Minn.
Letz, J. F......Milwaukee, Wis.
Lien, Nels ....Eveleth, Minn.
Lindberg, J. F....Hibbing, Minn.
Locker, W. H....Duluth, Minn.
Loudenback, C. I...Chicago, Ill.
Lutes, J. S......Biwabik, Minn.

Mace, R. E........Duluth, Minn.
Markell, John....Duluth, Minn.
Mars, W. P......Duluth, Minn.
Martin, E. C........Chicago, Ill.
Middlemise, B. A.Hibbing, Minn.
Mitchell, H. E....Eveleth, Minn.
Mitchell, R. J....Eveleth, Minn.
Mitchell, Pentecost.Duluth, Minn.
Mitchell, W. A....Chicago, Ill.
Mowatt N. P......Duluth, Minn.
Murray, Robert ..Hibbing, Minn.
McCord, R. D......Duluth, Minn.
McDonald, D. B....Duluth, Minn.
McDowell, John..Hibbing, Minn.
McGee, M. B.Crystal Falls, Mich.
McGonagle, W. A...Duluth, Minn.
McLane, John H..Duluth, Minn.
McNamara, T. B.Ironwood, Mich.
McNeil, E. D....Virginia, Minn.
McRandall, W. E.Bessemer, Mich.

Nelson, S. T........Chicago, Ill.
Newett, Wm. H.Ishpeming, Mich.

Oberg, Anton C..Hibbing, Minn.
Olcott, W. J......Duluth, Minn.
Orr, F. D........Duluth, Minn.
Overpeck, H. W..Virginia, Minn.

Parker, E. W..Washington, D. C.
Pascoe, Peter W..Republic, Mich.
Pascoe, P. W., Jr.Republic, Mich.
Pelling, W. T. Jr.Hibbing, Minn.
Pendry, Wm. ....Duluth, Minn.
Penniman, D. C...............
.... Minneapolis, Minn.
Perkins, F. J..Ironwood, Mich.
Peterson, A. Y................
...........Carson Lake, Minn.
Phillips, W. G....Duluth, Minn.
Philbin, D. M.....Duluth, Minn.
Powell, D. W..Marquette, Mich.
Power, R..........Duluth, Minn.
Prescott, Fred M.Milwaukee, Wis.
Prescott, L. L..Menominee, Mich.
Prince, W. J......Duluth, Minn.
Pursell, H. E.....Kewanee, Ills.

Quigley, G. J........Antigo, Wis.
Quine, John T..Ishpeming, Mich.
Quine, Wm.....Ishpeming, Mich.
Quinn, C. K......Virginia, Minn.

Raisky, F. ....Ishpeming, Mich.
Raley, R. J.......Duluth, Minn.
Redfern, John A..Hibbing, Minn.
Redner, A. E....Ironwood, Mich.
Reifel, H. T....Nashwauk, Minn.
Richards, W. J................
.... Crystal Falls, Mich.
Richards, M. E..Virginia, Minn.
Richards, John C..Virginia, Minn.
Roberts, Harry ....Duluth, Minn.
Rowe, W. C....Bessemer, Mich.
Rowe, Nathaniel.Ishpeming, Mich.
Rouchleau, L..Minneapolis, Minn.
Rough, J. H....Negaunee, Mich.
Rough, J. H., Jr.Negaunee, Mich.
Rumsey, S. S......Duluth, Minn.

Salsich, L. R......Duluth, Minn.
Sampson, John....Ashland, Wis.
Schubert, Geo. P.Hancock, Mich.
Scott, A. J.....Iron River, Mich.
Scott, Harry, M....Chicago, Ill.
Searle, C. E....Milwaukee, Wis.
Sebenius, J. Uno..Duluth, Minn.
Sellwood, R. M....Duluth, Minn.
Sheldon, A. F..Marquette, Mich.
Shove, B. W....Ironwood, Mich.
Silliman, A. P....Hibbing, Minn.
Silliman, T. B....Hibbing, Minn.
Silver, C. R........Chicago, Ill.
Smith, Bert ....Ironwood, Mich.
Sparks, B. F....Houghton, Mich.
Stakel, C. J....Ishpeming, Mich.
Sutherland, D. E.Ironwood, Mich.
Sullivan, A. J....Chisholm, Minn.
Swain, R. A..Minneapolis, Minn.
Swift, G. D........Duluth, Minn.

Talboys, H. H....Duluth, Minn.
Taley, D..........Duluth, Minn.
Tancig, A........Hibbing, Minn.
Tappan, W. M....Hibbing, Minn.
Thompson, G. H..Hibbing, Minn.
Thomson, C. A..St. Paul, Minn.
Traver, W. H......Chicago, Ill.
Trebilcock, Wm. ....
..........North Freedom, Wis.
Trebilcock, J...Ishpeming, Mich.
Trevarrow, H...Negaunee, Mich.
Trevarthan, W. J.............
.... Bessemer, Mich.
Trezona, Charles ...Ely, Minn.
Tubby, C. W....St. Paul, Minn.
Turner, C. N....Milwaukee, Wis.
Tyler, W. E........Mendota, Ill.

Ulizen, B. A......Crosby, Minn.
Ulrich, W. F....Chisholm, Minn.

VanBarneveld, Charles E......
.... San Francisco, Calif.
Vilas, R. L....Ishpeming, Mich.
Vivian, J. G......Duluth, Minn.
Vogel, F. A....New York, N. Y.

Wall, J. S.....Iron River, Mich.
Ware, W. F....Negaunee, Mich.
Watson, C. H.Crystal Falls, Mich.
Wearne, Wm......Hibbing, Minn.
Webb, F. J........Duluth, Minn.
Webb, W. M......Gilbert, Minn.
Welker, W. F......Ashland, Wis.
Wells, Pearson..Ironwood, Mich.
West, W. J......Hibbing, Minn.
Westcott, J. W..Riverton, Minn.
White, J. W.......Duluth, Minn.
White, Wm......Virginia, Minn.
Whitehead, R. G..Amasa, Mich.
Whitney, J. H....Oshkosh, Wis.
Whitney, A. E....Oshkosh, Wis.
Whiteside, Robert..Duluth, Minn.
Wilcox, L. L......Gilbert, Minn.
Willard, P. D.....Gilbert, Minn.
Wilson, A. O....Hibbing, Minn.
Williams, T. H.......Ely, Minn.
Williams, P. S....Ramsay, Mich.
Winchell, H. V.Minneapolis, Minn.
Wivell, Wm....Nashwauk, Minn.
Woodbridge, R. M..Duluth, Minn.
Woodbridge, D. E..Duluth, Minn.
Woodworth, G. L.............
.... Iron River, Mich.
Woolf, P. J..Minneapolis, Minn.

Yates, W. H.......Duluth, Minn.
Yungbluth, A. J.Ishpeming, Mich.
Yungbluth, R. O.Ishpeming, Mich.

Ziesing, August.....Chicago, Ill.
Zimmerman, W. G..Duluth, Minn.

PAPERS

REPORT OF COMMITTEE ON THE PRACTICE FOR THE PREVENTION OF ACCIDENTS.

The Committee on the Practice for the Prevention of Accidents met in Ishpeming on March 26th, 1913, and the following members were present: J. E. Jopling, Ishpeming, Chairman; C. E. Lawrence, Iron Mountain; D. E. Sutherland, Ironwood, A. M. Gow, Duluth.

After duly considering the subject and discussing the various suggestions which were made by members of the Committee, the following resolutions were adopted:

Uniform Mining Rules—It is thought advisable to collect information of mining rules used in the Lake Superior mining district and to compare the same with those published in the report to the American Mining Congress, American Institute of Mining Engineers and the Mining & Metallurgical Society of America by the Committee on Uniform Mining Laws for Prevention of Mine Accidents, October, 1910, and the proposed form now being prepared by the Bureau of Mines; also that a competent person or persons should be employed under the direction of the Committee to draft a set of rules to be presented to the Lake Superior Mining Institute as a proposed standard for mines in the Lake Superior district.

Uniform Reports of County Mine Inspectors—It is suggested that the reports of the County Mine Inspectors of Michigan, Wisconsin and Minnesota be standardized; that the reports should cover the calendar year, and that they should include fatal and serious accidents of all mine employes whether surface or underground. In the judgment of the Committee these accidents should be classified according to a uniform system and recorded upon a uniform blank.

Classification of Accidents—It is recommended that investigations be made leading to a uniform classification of accidents for mines in the Lake Superior district.

Reports as to Carrying Out Safety Rules—The Committee recommends the collection of blank forms used for reports to show the carrying out of safety rules adopted, these blank forms to be only such as are used by employes in various departments of the mining companies for their information.

Contagious Diseases—It is the sense of this Committee that more definite action should be taken in the matter of contagious diseases in the different localities, in the form of a rigid quarantine to be established by the health officer.

Physical Examination of Employes—Investigations should be made to find out what is being done in the matter of physical examination of employes by employers of labor.

Publicity of Mining Rules—It is recommended that suggestions be made as to the dissemination of the Rules for the Prevention of Accidents among employes.

Mine Rescue Car—It is recommended that the Bureau of Mines be requested to send mine rescue car No. 8 to the Mesabi Range at the time of the meeting of the Institute.

It is requested that the Council comment on the above resolutions, stating whether an appropriation will be made to carry out any of the investigations enumerated above.

The resignation of Mr. Edward Koepel of Beacon Hill, Michigan, was submitted to the Committee. The Committee offers this resignation and suggests that Mr. W. H. Schacht of Painesdale, Michigan, be appointed in his place.

The Committee met for the second time in Ishpeming on July 22nd, 1913, and the following members were present: J. E. Jopling, Ishpeming, Chairman; C. E. Lawrence, Palatka; A. M. Gow, Duluth; W. H. Schacht, Painesdale.

In response to a request to Mr. H. M. Wilson of the Bureau of Mines, Pittsburg, for consultation at this meeting, he sent Mr. Edwin Higgins, District Engineer, United

States Bureau of Mines, who was present and gave much valuable assistance and information.

The resolutions adopted at the former meeting were further discussed. Mr. Gow had prepared a series of fifteen charts showing in parallel columns the mining rules adopted by The Cleveland-Cliffs Iron Company, The Inland Steel Company, Pickands, Mather & Company, and the Oliver Iron Mining Co. These fifteen classifications are as follows:

1. Locomotives, Steam Shovels and Cars.
2. Boilers and Boiler Houses.
3. Engine Rooms, Engine Hoists and Signals.
4. Shops, Tools and Machines.
5. Buildings, Headframes and Structures.
6. Open Pits, Tracks, Roads and Test Pits.
7. Standard Signs and Danger Signals.
8. Cages, Skips, Buckets, Ropes, Cables, Hooks, Chains and Sheaves.
9. Shafts, Ladderways, Ladders and Pump Stations.
10. Underground Mining, Timbering and Tramming.
11. Explosives.
12. General Safety Rules and Admonitions.
13. Electrical Rules and Regulations.
14. Medical and Sanitary.
15. Fire Protection and Precautions.

In the printed rules of the different mining companies referred to there is the widest divergence in classification, in number of rules bearing upon a particular subject and in the emphasis placed upon them. Your Committee has therefore found it impossible to frame a code of safety rules to present at the meeting of the Institute for adoption. A committee of mining engineers consisting of Messrs. Ingalls, Channing, Douglas, Finlay and Hammond, framed a proposed code. We would recommend that the Lake Superior Mining Institute appoint a similar committee of operating officials from the copper and iron ranges who shall make a report at the next meeting of the Institute as to the desirability of a uni-

form code, and shall present such a code for discussion at that time.

We deem it desirable that the safety rules to be adopted should be based upon some classification. We consider it advisable that such a classification should conform to that adopted by the United States Bureau of Mines in collecting statistics of metal mining accidents. This classification appears to us to be thoroughly practical and inasmuch as the mining companies are required to report to this department all accidents in accordance with this classification, we see every reason why we should adopt it for our own reports.

Presented herewith is a copy of the Bureau of Mines classification. Such an arrangement will simplify to a great extent the making of reports to the government by the mining companies.

Owing to the desirability of having uniform reports made by mining companies and by county mine inspectors, it is recommended that the above form of report, except in relation to minor accidents, be adopted by county mine inspectors, thus making their reports uniform with that called for by the Bureau of Mines.

In view of the fact that some county mine inspectors report only on underground accidents while others report on both surface and underground accidents, complications have arisen in the past in comparing the accident reports of the various districts. To improve this condition we recommend that all county mine inspectors make their reports covering both surface and underground. The word "surface" is here meant to include all operations having to do with the actual operation of the mine, excluding all those which are at present covered by factory or mill inspection.

From such information as we are able to obtain we are satisfied that the installation of safety devices and appliances, such as guards, toe-boards, hand rails, etc., is the smaller part of the safety movement. We believe that efficiency in safety can only be attained by education and constant agitation of

the subject and the hearty co-operation of the employes with the management. The management, in every case, should show its willingness to do its part in the installation of guards and appliances, but the most efficient work in the cause of safety must be done by methods which will constantly keep before the mind of every employe the fact that upon him rests an individual and personal responsibility. To put it another way, the problem is a psychological and not a mechanical one. We therefore urge that in addition to the installation of guards and appliances that consideration be given to those means and methods, other than mechanical, which will secure the co-operation of the employes in and about the mines.

Your Committee gave consideration to the question of the physical examination of employes and while we believe that good results might be obtained from such procedure, we are not, at this time, prepared to make any definite recommendations whatsoever.

CLASSIFICATION OF ACCIDENTS IN METAL MINES ACCORDING TO THE UNITED STATES BUREAU OF MINES.

Sub-Divided Under Following Caption—

KILLED.

SERIOUSLY INJURED. (Broken arm, leg, ribs, or other injury involving loss of 20 or more days' work.)

SLIGHTLY INJURED. (Injury involving loss of more than 1 day's work, but less than 20.)

Underground

1. By fall of rock or ore from roof or wall.
2. By rock or ore while loading at working face.
3. By timber or hand tools.
4. By explosives (includes premature blasts, explosion of misfires, flying pieces from blasts, suffocation by gases from blasts, etc.)
5. By haulage accidents (by mine cars, mine locomotives, breakage of rope, etc.)
6. By falling down chute, winze, raise, or stope.
7. By run of ore from chute or pocket.
8. By drilling accidents (by machine or hand drills.)
9. By electricity (shock or burn.)†
10. By machinery (pumps, hoisting and haulage machinery, etc., not including locomotives or drills.)

11. By mine fires.
12. By suffocation from natural gases.
13. By inrush of water.
14. By stepping on nail.
15. By other causes. (Please list, showing causes.)

Total number killed or injured underground.

Shaft Accidents

16. By falling down shafts.
17. By objects falling down shafts.
18. By breaking of cables.
19. By overwinding.
20. By skip or cage.
21. By other causes. (Please list, showing causes.)

Total number killed or injured by shaft accidents.

Surface Accidents*

(Where surface mining is not performed.)

22. By mine cars or mine locomotives.
23. By railway cars and locomotives.
24. By run or fall of ore in or from ore bins.
25. By falls of persons.
26. By stepping on nail.
27. By hand tools, axes, bars, etc.
28. By electricity.†
29. By machinery.
30. By other causes. (Please list, showing causes.)

Total number killed or injured by surface accidents.

Surface Accidents*

(Where surface mining is performed.)

31. By falls or slides of rock or ore.
32. By explosives (including premature blasts, explosion of misfires, flying pieces from blasts, etc.)
33. By haulage accidents (by cars, locomotives, etc.)
34. By steam shovels.
35. By falls of persons.
36. By falls of derricks, booms, etc.
37. By run or fall of ore in or from ore bins.
38. By machinery (other than locomotives or steam shovels.)
39. By electricity.†
40. By hand tools.
41. By other causes. (Please list, showing causes.)

Total number killed or injured by surface accidents.

Grand total.

*Does not include accidents in ore dressing.

†Please state the voltage of current.

PAPERS PUBLISHED BY THE INSTITUTE, WHICH TREAT OF MINE SAFETY AND SOCIAL CONDITIONS.

SANITATION FOR MINE LOCATIONS.

BY W. H. MOULTON, ISHPEMING, MICH.*

Sanitation is the practical application of knowledge and science to the preservation of health. There is no one thing that more directly affects the successful operation of our mines than the health and well being of the men, and we are now coming to realize that it is a practical as well as a scientific matter. The value of sanitation is being recognized today in all branches of industry as well as in its effect upon a community as a whole. Our higher educational institutions have regular courses in this subject and men are graduated in this branch of engineering.

It is undoubtedly true, that the better living conditions and better physical health make for more satisfactory service. The health of the men may be conserved in many ways which are of practical application around our mines. Much has already been accomplished and due credit should be given to the many companies who have given special consideration to the health of its men.

The old wooden dry, of a comparatively few years ago, is now being replaced by the modern one with ample hot and cold water, individual basins or buckets, lockers for the street and mine clothes, and drying and ventilating systems which effectually take care of the wet clothing of the miner. The plan of suspending the wet clothes by means of a rope or chain, with individual lock, has much to commend it. The shower bath, which is a part of all the modern drys, has made it possible for the men to bathe who have not the proper facilities at home. Their constant use has demonstrated their value.

*Secretary Pension Department, The Cleveland-Cliffs Iron Co.

The introduction of water closets in the drys has not always met with complete success, but in the majority of cases it is working very advantageously and improving the underground conditions.

Dry closets should be placed in every main level and they should be provided in proportion of one to every twenty-five men. These closets should be made of wood or iron of a size to be conveniently handled by two men. They should be taken to the surface and washed out with the hose when emptied. Lime should be kept convenient to the boxes and used regularly. There is no more fruitful source of disease than the human excreta left in the mine workings.

The water that the men drink should have the most careful attention and under no circumstances should the men be permitted to drink water that is not known to be pure. This can only be made possible by furnishing good water so that the men can readily obtain it. The plan of the Oliver Iron Mining Company in providing bubbling fountains, thus doing away with the old dirty drinking cup, is also to be highly commended.

Anything that will lessen those diseases frequent among our miners such as tuberculosis, typhoid, and other contagious or communicable diseases, should be carefully considered. There should be a more rigid quarantine in cases of contagious diseases, and it is desirable that the mining companies coöperate more fully with the health officers and that such regulations be made and enforced that our unenviable record in contagious diseases, especially in diphtheria and scarlet fever may be greatly improved upon.

Owing to the relation that the physicians bear to the mining companies, they may hesitate to suggest things which might appear as criticism of existing conditions or methods of mine management, and should therefore be given full authority to correct undesirable conditions. I believe we would get better results in this matter of sanitation by employing the physicians, at a stated added remuneration, to make periodical inspection of the entire properties.

Proper ventilation should be provided in all of our mines which would add to the efficiency of the men and incidentally prolong their lives. Tuberculosis and similar diseases would be less prevalent.

The sanitary condition of the home has a great influence on the lives of the men. What can reasonably be expected of a man living in unhealthful surroundings?

I believe that there is a duty that the mining companies owe to men employed by them and the community in which they live. One of the most efficient ways of fulfilling this obligation is in providing satisfactory homes, with healthful surroundings for the men and their families. Any work of this kind must be wisely done and in such a way that the men will be led to cooperate in it so that there will be no suggestion of paternatism in its methods or manner of inforcement. The importance of providing houses for rental is generally recognized but after the house is provided it is just as essential that its condition be not neglected. We have seen houses with no provision for waste water, which must be thrown out upon the ground. The only good things that may be said of this is that it usually provides a good place for the propagation of fish worms, but it also assists in the propagation of other less desirable things.

The old boxed-in cupboard sink may yet be found which is a place for refuse and vermin, and is so frequently a rotten, dirty, slimy hole. If there are such, let them be torn out.

The drainage around our houses and other properties requires careful attention. Ditches should be dug and kept open even if the boys fill them up, and no stagnant water left to breed mosquitoes and infection.

Garbage and refuse should be deposited in covered receptacles, preferably galvanized iron cans, and where such services are not rendered by the city or village, the companies should provide for its regular collection and disposal not less frequent than once each week. It has been found feasible in some places to have the occupants of the premises purchase

the cans, which are supplied at wholesale rates, or through the company at cost, with the understanding that proper collection is assured. Rubbish should not be dumped around promiscuously but deposited in a designated place, collected, and disposed of. Few of the men have time or facilities for economically doing this and if not looked after by the city or the company, it will not be taken care of at all satisfactorily. A refuse burner, costing very little, can be so located as to make the disposal of rubbish a simple matter and comparatively an inexpensive one.

It is desirable in many cases to permit the keeping of a cow or horse but provision should be made for the care of the manure. It should not be allowed to accumulate from month to month but should be removed promptly. It also should be treated with chloride of lime, or with a kerosene carbolic acid mixture.

The companies should encourage the beautifying of home surroundings but it is even more important to see that the sanitary conditions are what they should be. In those localities having no sewer connections, the question of out-houses is a serious matter. Too often the out-house is set on the ground with no proper receptacle for the human excreta which often spreads over the ground, even if a pit is dug. This is frequently allowed to collect throughout the season thus becoming a menace to the family. Often the houses are more or less open; vermin enters without hindrance; the ever-present disease-carrying fly freely finds access, goes from there to the house, feeds on the baby, and has even been known to be on the household food. We have just begun to appreciate the danger from these pests. The companies which have already set us an example in their campaign against the fly should be congratulated, and it should also stimulate the rest of us to make an equal effort. These out-houses should be provided with a proper receptacle which should be emptied at regular and not too separate intervals, and properly cleaned. Either earth, slaked lime or chloride of lime should be constantly used.

Much good can be accomplished by the teaching of sanitation in the public and parochial schools. Some of us may be too old to take kindly to the need of sanitary precautions but it is not too much to expect that the young may be taught to look on these matters as important and to a considerable degree help to improve conditions.

The value of the physical inspection of school children is only just beginning to be appreciated. It should be in effect in all of our communities. It is a health precaution of great merit.

The most efficient agency in extending the benefit of this work of sanitation is the Visiting or Public Health Nurse. A number of mining companies in the Lake Superior region have already introduced this service with much success. No other person can have the same opportunity of reaching the homes and the members of the families and assisting in the understanding of the benefits to be derived from fresh air, cleanliness and other sanitary precautions. The importance of fresh air cannot be emphasized too strongly.

The advantage of all this is a better home life, the prevention of serious contagion, and the men in better condition for work. Anything that tends to the more regular work of the men is well worth consideration.

The mining companies of the Lake Superior region are to be commended for the work that has been done for the men, their families, and the communities in which their operations are conducted, but with this commendation must come the realization that there is still much to be accomplished. This can best be done by makng some one person directly responsible for the execution of the plans and methods of sanitation authorized by the mine manager.

WINONA STAMP-MILL.*

BY R. R. SEEBER, WINONA, MICH.

From October, 1906, to November, 1907, the Winona mine shipped rock from one shaft to the Adventure stamp-mill. This rock showed a total copper content of about twenty pounds per ton stamped. A large part of the contained copper was fine or flaky, making extraction very difficult.

Winona Stamp Mill

Only a trifle over thirteen pounds per ton stamped was recovered during this period. With such a low grade ore, it was obviously necessary to practice every economy if a profit was

*Winona Copper Company, Winona, Michigan.

to be obtained. The transportation cost per ton stamped was 17.5 cents during this period, or considerably over one cent per pound on the copper obtained. If a stamp-mill were to be built on the mine location without otherwise increasing operating expenses evidently a large proportion of this expense might be eliminated.

There are two principal reasons for the location of stamp-mills away from the mine, namely: To provide ample water for washing and to provide room for disposal of tailings. To meet the water requirement, with the mill on the mine at Winona, a dam across the Sleeping river was necessary. For a two-head mill it would also be necessary to use at least 50 per cent of the water over and over as the stream flow is only about 3,000,000 gals. per 24 hours.

To meet the sand room requirements, some de-watering device and sand-stacking equipment would be necessary.

After considerable study it was decided that these requirements could be met without prohibitive first cost or undue operating expense and work on a two-head mill was begun May 22d, 1909.

The location chosen was a hillside between No. 4 shaft, Winona, and No. 1 shaft, King Philip. On the line of the stamp heads pipes were driven which, when stopped, indicated a layer of hard material at a depth of 40 feet below the intended plane of the stamp base. On this material the concrete foundation of each stamp head was expected to rest. This foundation is cylindrical. A steel caisson, 15 ft. in diameter, was weighted with a concrete ring 3 ft. thick and sunk as a drop shaft. When the expected layer of hard material was reached it was found to be thin and to be underlain by at least 80 ft. of sand, some of which was wet. Sinking was therefore continued until a sufficiently hard layer of material was encountered at about 55 ft. below the intended plane of the stamp base. The concrete ring was blocked up and a mushroom foot of concrete built in, as shown in the drawing, Fig. 3. The top 7 ft. of the caisson and concrete

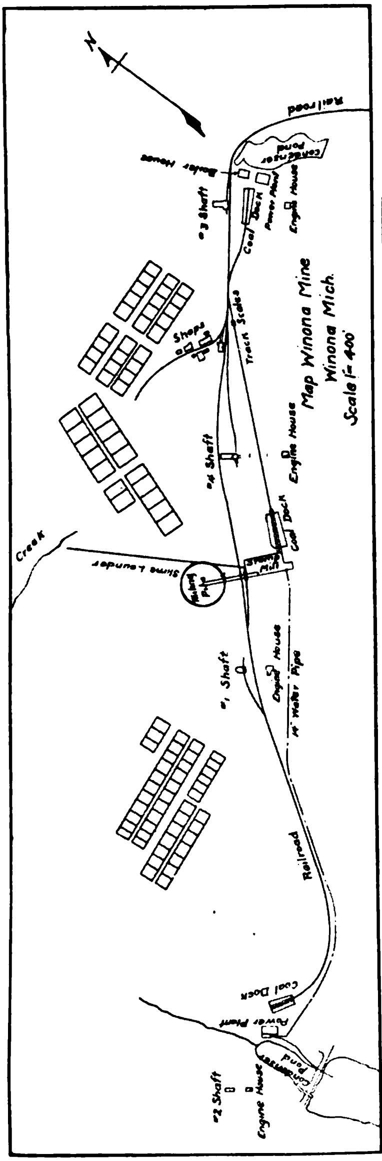

Map Winona Mine
Winona Mich.
Scale 1"= 400'
Railroad
Condenser Pond
Boiler House
#3 Shaft
Coal Dock
Power Plant
Engine House
Track Scales
Shops
#4 Shaft
Creek
Slime Launder
Stamp Mill
#1 Shaft
14" Water Pipe
Power Plant
#2 Shaft

Fig. 1

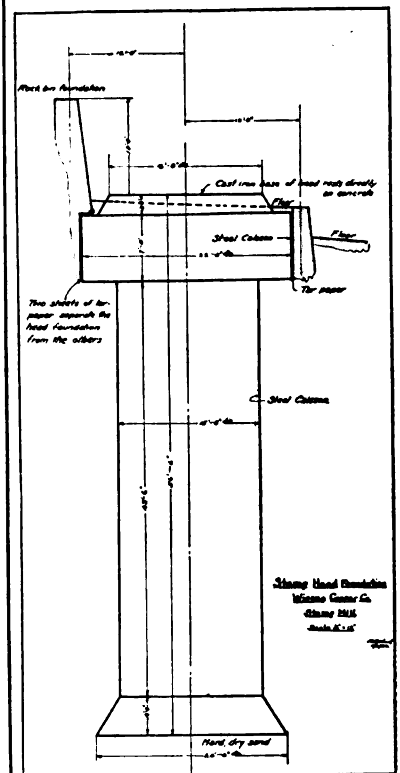

Steel Column
Tar paper
Floor
Hard, dry sand

Fig. 3

foundation was made 22 ft. in diameter in order to accommodate the 16-ft. square base for the head casting. The castings below the rock (from mortar down) weigh about 80 tons. The total weight of the stamp is about 115 tons. When sinking the 15-ft. caisson it was found that 43 ft. of concrete ring would be held up by the friction of the sand against the outer surface of the steel shell. Including the 7 feet of 22-ft. ring, this skin friction would care for at least 400 tons of total weight of about 1,050 tons to be supported, (935 tons foundation; 115 tons stamp), leaving 650 tons to be supported on the sand under the 20-ft. ring, 203 square ft. and the 20-ft. diameter base (314 square ft.) or a load of a little over 1.25 tons per square ft. on the total area of 517 square ft.

Velocity cards of the stamps show a blow of from 24 to 33-ft. tons. This is partly absorbed in crushing rock. As a foundation to assist in absorbing the balance there are supplied 80 tons of cast iron and 930 tons of concrete. After two years of use, no settling of foundations is in evidence and I am inclined to the belief that the foundations are much larger than is necessary. The concrete for all purposes was supplied from a central mixing station using a Smith mixer of one-half yd. capacity. Sand and crushed rock were dumped from a temporary track and trestle into temporary bins above the mixer. Rock was first run into the hopper up to a mark, then sand. Cement from sacks was emptied on top and the charge dumped into the mixer. The mixed charge was emptied into two-wheeled, steel-concrete buggies, wheeled over runways and dumped into the forms. Two of the steel rock bins were used for storing sand and rock for floors and other concrete work, placed after the erection of most of the steel.

Foundation walls were all of concrete, of a 1:3:5 mixture; all walls stand on dry, hard sand. The bin foundation walls were separated from the stamp foundations by tarred paper in order that any settling of the latter need not disturb the building foundations. The octagonal foundations for the rock bins were tied together, to a certain extent, by old wire cable.

The detailed construction of the concrete settling tanks is best shown in Photo "B," and drawings, Figs. 4 and 5. Under the slime department floors eight tanks were built for settling the slimes and decanting the dirty water, to be re-used in the mill. These tanks are 46 ft. long by 24 ft. wide, and

Photo B

14 ft. deep. The walls are 14 to 24 in. thick and are reinforced by vertical iron rods three-quarter in. in diameter, bent at the bottoms to make the joint into the floor.

It was very difficult to place and tamp the concrete about these rods, but the walls when completed showed but a few small leaks which were easily stopped and give no trouble in operation.

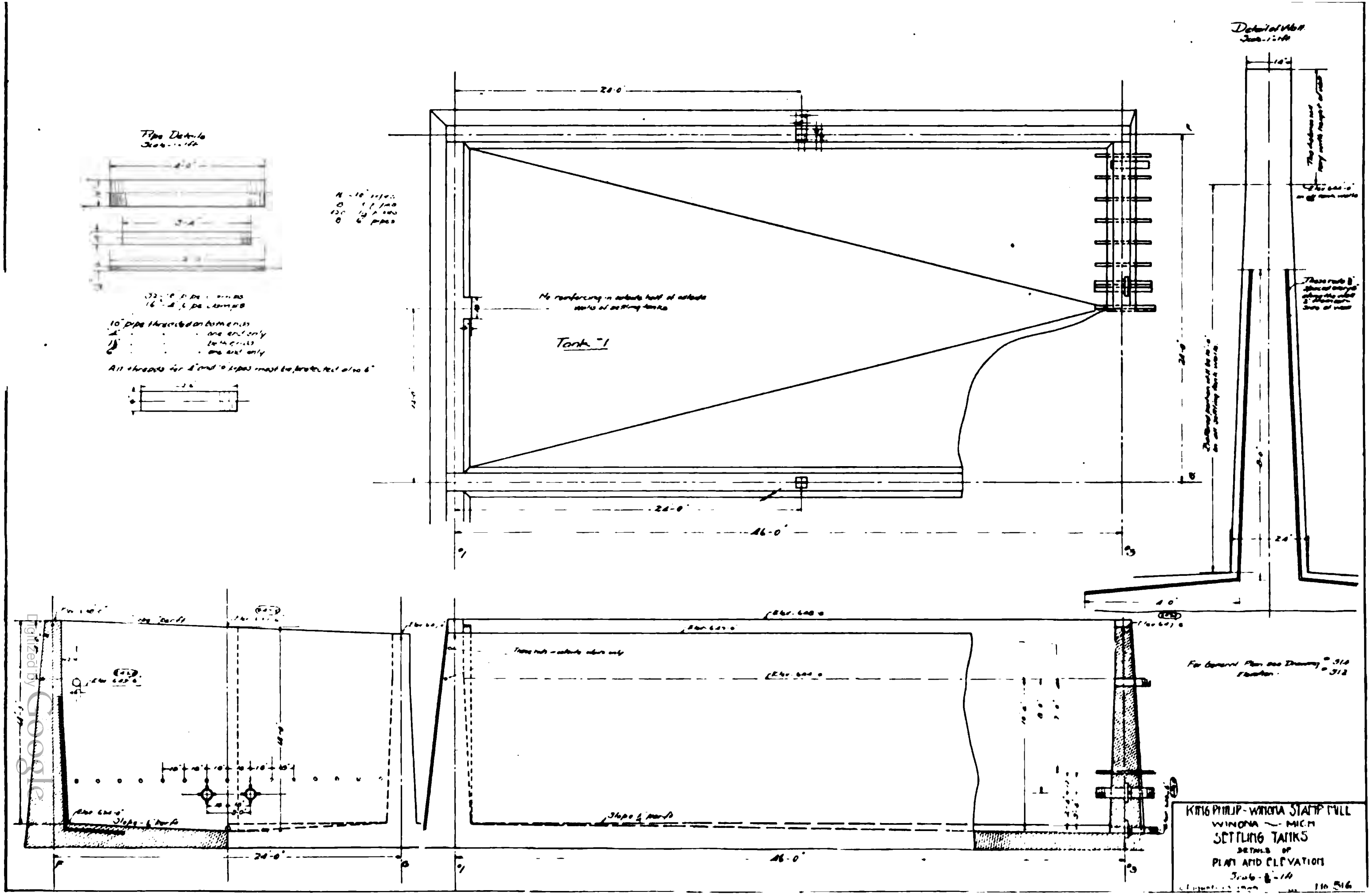

KING PHILIP-WINONA STAMP MILL
WINONA — MICH
SETTLING TANKS
DETAILS OF
PLAN AND ELEVATION
Tank #1
Pipe Details
Detail of Wall
No reinforcing in outside half of outside walls of settling tanks
For General Plan see Drawing #310, #312
24-0
46-0
10" pipe threaded on both ends
All threads for 4" and 10" pipes must be protected also 6"

Fig. 4

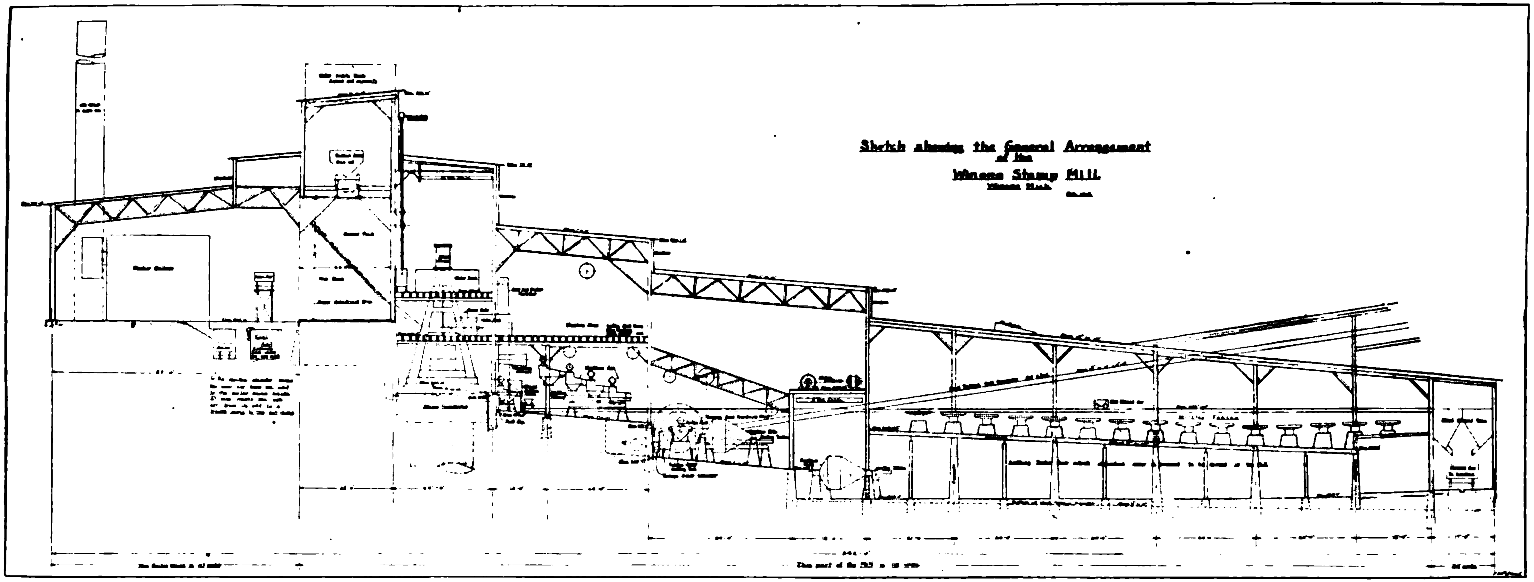
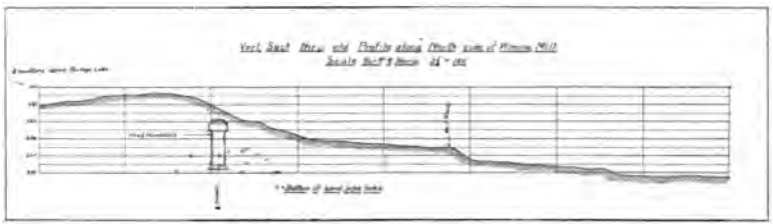


Fig. 5



Vertical Section Through Profile Along the North Side of Winona Stamp Mill.

The steel structure was made and erected by the Wisconsin Bridge & Iron Company. In general arrangement, it is the same as the usual copper country mill. Circular steel rock bins are used, two supplying each head, the openings being run together high up the sides thus allowing a large proportion of the contents to run out freely. The storage capacity of four bins is about 525 tons, or sufficient to last over night.

Instead of a trolley beam over the stamps a light crane beam was installed. This has proved very convenient in op-

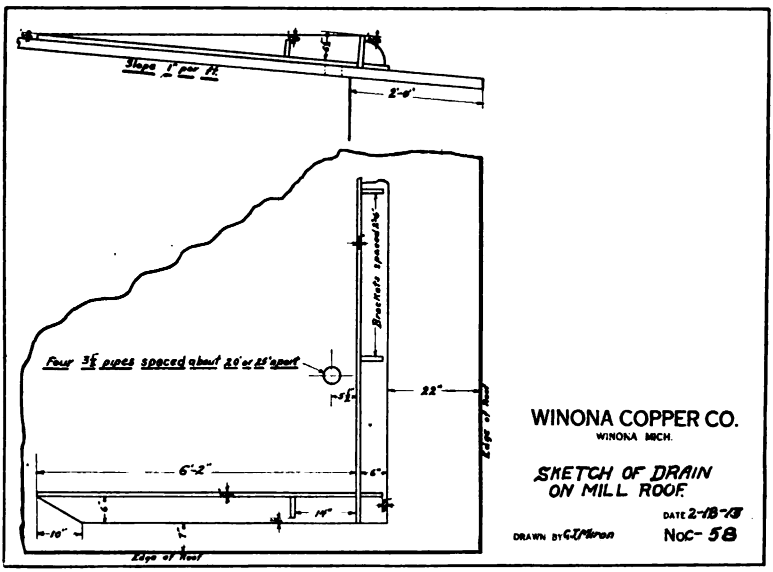


Fig. 10

erating as well as during erection. This crane also handles all roll parts, etc.

Over the slime department, at right angles to the line of the stamps, it was impossible to get in the usual step form of roof in a manner to allow sufficient light. Skylights of wire-glass were therefore tried and have proved satisfactory although snow sometimes accumulates over them. The roof is the usual form of matched flooring but is covered with Brooks' 4-ply asbestos roofing, in sheets about 3 ft. by 7 ft. During the first winter much trouble was experienced with ice on

the eaves. As snow melts over the main body of the warm roofs the water runs down until it strikes the eaves, which are cold. It there freezes and makes a dam of ice which backs

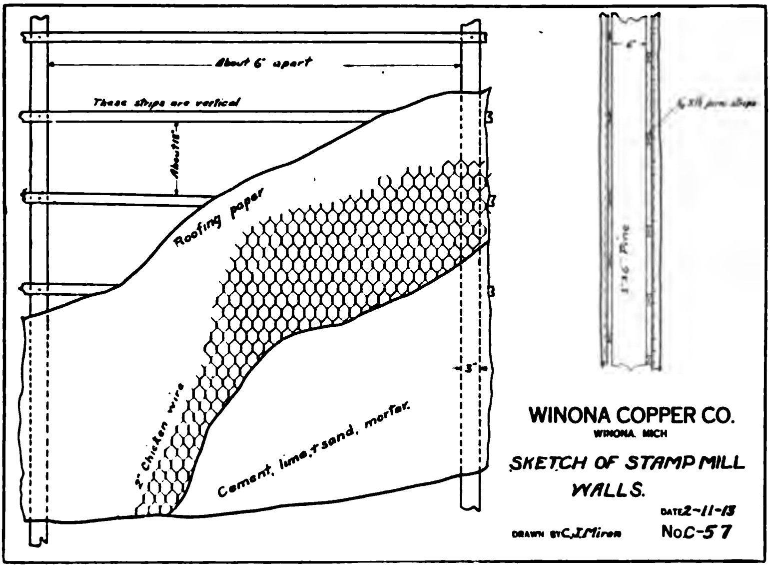


Fig. 8

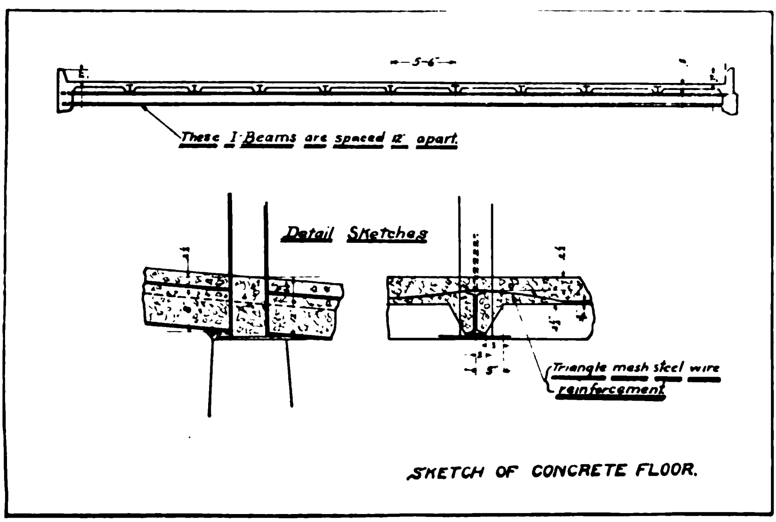


Fig. 9

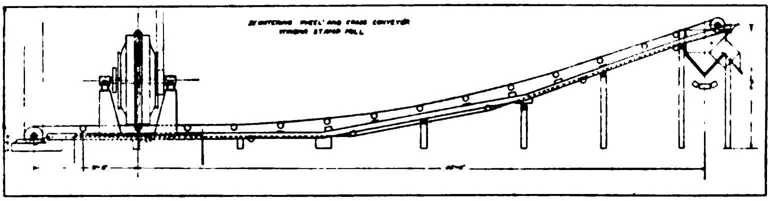
the water up until it runs through some opening or freezes and adds to the ice already formed. Immense icicles were sometimes formed down the sides of the building to the ground. This trouble has been entirely overcome by building wooden dams just back of the line of the eaves on each step of roof. These dams slope to holes in the roof leading to a piping system inside the mill which carries off the water. The warm air from the interior keeps these pipes free from ice, and as fast as snow melts it runs off the roof. This scheme was copied from a similar one at the Calumet & Hecla mills but I have seen no description of it in print.

The main slime department floor over the top of the settling tanks is made of concrete reinforced with triangle-mesh wire. The outside walls of the building are formed by a thick coat of cement plaster on a chicken-wire reinforcement. The inside face of the wall is made in the same manner, which leaves a good air space in the wall. The mortar is made of cement, sand, and a little lime. A detailed sketch is shown in Figs. 8 and 9.

The bins for storing mineral are in the bottom of the mill, over a spur from the railroad. They are made of steel and have 10 compartments, each of 200 cu. ft. capacity. A narrow-gauge track runs along one side of the mill and across it, back of the jigs. Headings and No. 1 mineral from the jigs are emptied directly into cars running on this track. Settling bins for finer grades of mineral are situated above this track, on the head foundation level. All the finer grades of mineral are pumped back to these bins from the various settling boxes of tables and jigs and excess water is allowed to drain off. When comparatively dry, this mineral is dumped into the mineral car, and trammed over a track scale at the lower end of the mill and dumped into the bins over the railroad track. All mineral is shipped in steel mineral cars belonging to the Copper Range Railroad Company.

Rough tailings from the tails of the jigs are de-watered by a large wheel and fed to a cross conveyor which discharges

over the main conveyor running the long way of the mill. This main conveyor operates within a steel bridge supported on three steel towers and, when dumping, reaches a maximum heighth of 84 ft. above the track level at the bottom of the mill and 123 ft. above the ground. The conveyor is of the usual Robins type with troughing idlers on a 30 degree angle. The belt is balata, 20 in. wide. It has been in operation since



De-watering Wheel and Cross Conveyor, Winona Stamp Mill.

March, 1911, and apparently has a long time yet to run before needing replacement. The conveyor is inclined 1¾ in. per ft., or 8 deg. 18 min.

A slime launder of steel extends 1,200 ft. below the mill. This has a semi-circular bottom, with straight sides. We are now, (March, 1913) putting in the first steel liners. The wear is only around the rivet heads where eddy-currents are set up. This launder slopes ¼ of an in. to the ft. and carries all the slime material. It empties into a ravine which joins the main river at a distance of about a mile and a half from the mill but on land belonging to the Winona Copper Company. If necessary, at any time in the future, a dam could be built across the river at this point and water pumped back to the mill.

A circular steel bin that can hold about four cars of coarse sand is situated over the track to the mineral bin. This can be filled from a separate belt conveyor parallel to the main conveyor and, during the summer months, much of the coarse sand is sold for concrete work and for railroad ballast.

The main trestle to the rock bins is used as a coal trestle. The coal plat is 30 ft. below the base of the rail. The floor is of concrete, about 4 in. thick. The usual coal adit under

the main trestle is also made from concrete. The storage capacity of the plat is about 6,000 tons. The trestle is of steel. The coal adit enters the boiler house at the same elevation as the ash adit in front of the boilers. An electric elevator elevates the car with ashes to an ash trestle and the car with coal to a trestle 8 ft. above the floor and running parallel to the boiler front. The coal supply is dumped on the floor and the boilers are fired by hand. The stack is of steel, brick lined. It is 150 ft. high and 6 ft. in diameter. The boilers were made by Parker, of Philadelphia. They are three in number, each 268 horsepower and are set in brick. They are equipped with Andrews' shaking grates, draft regulators and feedwater regulators.

The assay office is near the railroad at the bottom of the mill. It is supplied with the usual equipment for both fire and electrolytic assaying. A motor generator supplies the storage batteries for electrolytic work. A Tirrill gasolene gas plant supplies the gas.

A dam for the main water supply of the mill is situated on the Sleeping river, about 3,900 ft. from the mill. It is 440 ft. long and 27 ft. high. The width of the bank on top is 15 ft. The slope on the water side is 2 to 1 and on the down stream side is 2½ to 1. The spillway is 7 ft. wide and 8 ft. deep from the top of the concrete core wall. With all flash boards out of the spillway, the storage capacity of the dam is about 77,000,000 gals. Its volume is just about doubled by 5 ft. of flash boards. The core wall of the dam is concrete, 12 in. thick at the top and as much as 6 ft. at the very bottom. The sand fill was made mostly by the hydraulic process, a pump on the stream supplying water for washing sand from the banks. Both slopes are riprapped with coarse rock from the mine. A sheet steel intake 4 ft. square with a screen underneath, was first used but quickly became clogged with leaves, etc. A straight pipe 18 in. in diameter, the periphery filled with 1½ in. holes and rising above the highwater level, was then tried. This has given no trouble beyond catching in the ice once as the water level dropped.

The main pump is situated in a compressor house on the river bank. The pump was made by the Laidlaw-Dunn-Gordon Company. It has water cylinders 11¼ by 24 in. and steam cylinders 12 and 25 by 24 in. stroke. The cooling water for condensation is furnished by the main suction of the pump. Water enters the suction under a head of 5 pounds. Steam pressure is 200 pounds. The pumping capacity, at 67½ revolutions per minute, is 4,000,000 gals. per 24 hours.

Interior of Winona Mill

The pipe line connecting the pump to the surge tank on top of the stamp-mill is spiral-riveted double galvanized pipe, with bolted points and rubber gaskets. The pressure at the pump is 86 pounds per square in. with the pump running. We have ruptured several lengths of this pipe, the rupture cutting clear across the steel. This was probably due to flaws in the steel. The joints have not given trouble. The pipe is 14 in. in diameter and 3,900 ft. long. The surge tank on top

of the mill supplies pressure for fire lines. All piping for the mill is direct from this tank.

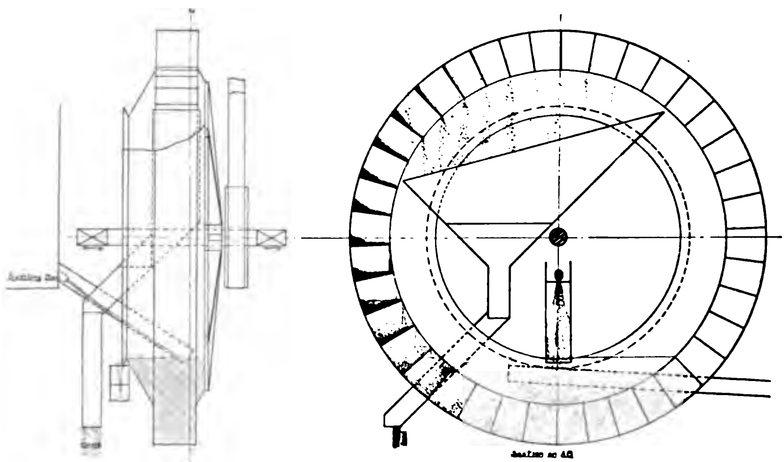
The steam stamps were made by the Allis-Chalmers Company. One is a simple stamp with a cylinder 24 in. dia. by 25 in. stroke and the other a compound with cylinders 16 and 32 in. dia. by 25 in. stroke. Both stamps have piston valves and only two eccentrics. The high-pressure cylinder of the compound stamp is on top and is removed bodily by the crane, if necessary to inspect the low-pressure cylinder or the piston. The rolls are of the rigid type and were made by the Allis-Chalmers Company. Four trommels are used instead of two.

The jigs are of the Woodbury system. One bull jig is used for the oversize and four four-compartment sets per head for the material through the trommels. Owing to the small percentage of No. 1 copper (medium-sized pieces) contained in the Winona rock, these jigs do not seem well adapted to the purpose. They do make an excellent separation of slimes for table treatment and provide a middling feed for regrinding mills. The jigs are supported on iron brackets instead of the usual timber supports. This makes it easier to get under the machines for adjustment and repairs and for washing floors.

The principal machine developed for the operation of this mill is the de-watering wheel. As it is necessary to re-use the water, the tailings had to be separated from it. The water carrying the tails of the jigs is comparatively free from slime so that it is kept separate as "clear water" and re-used as wash water. The first de-watering device tried consisted of a screen tacked on a cylindrical frame which revolved slowly. The tails were drawn through spigots onto the outside of this screen the water falling through and the coarse material going over with the screen on to the cross conveyor belt. This scheme was not satisfactory as the spigots required a great deal of attention, having a tendency to either clog or to run water as the feed varied. An 8-ft. wheel along the lines of the present wheel was then developed. This worked well but the 12-ft. diameter wheel now used gives more room for

launders, etc., and takes care of two heads. As shown by the drawing, Fig. 11, the de-watering wheel consists of a sheet steel water-tight wheel with radial partitions along the periphery forming pockets in which the sand is caught and lifted out of the water and discharged at the top of the wheel over an apron on to the belt conveyor. The sand is run from settling tanks through spigots into the bottom of the wheel. The water overflowing from the wheel is carried to the settling tanks and re-used.

The sand conveyor problem gave some little trouble be-



Dewatering Wheel.
Fig. 11

fore it was satisfactorily solved. The first cross conveyor used delivered sand to a bucket elevator which persisted in clogging and otherwise causing trouble. This was removed and the cross conveyor curved up to deliver directly to the main conveyor. Some trouble was experienced with the belts getting out of line but this was gradually eliminated until the sand conveyor equipment now has no special attendant. As a large pile of sand was piled up around the last tower of the sand conveyor the ground began to bulge up around the edge of the pile. Settlement of the outside tower came with this

movement and finally caused shearing of rivets on the upper side of the conveyor bridge over the middle tower. These rivets were then cut out and bolts in slots substituted. A pin joint was placed in the bottom of the truss. This allowed for about 2 ft. of settlement in the outer tower. The settling continued until it became necessary to cut the conveyor house free from the outside tower. The conveyor bridge is now supported at the far end on blocking and jacks from the steel of the tower embedded in the sandpile. If settlement continues, the conveyor bridge will be jacked up to keep pace. As the sand accumulates the conveyor will be extended and

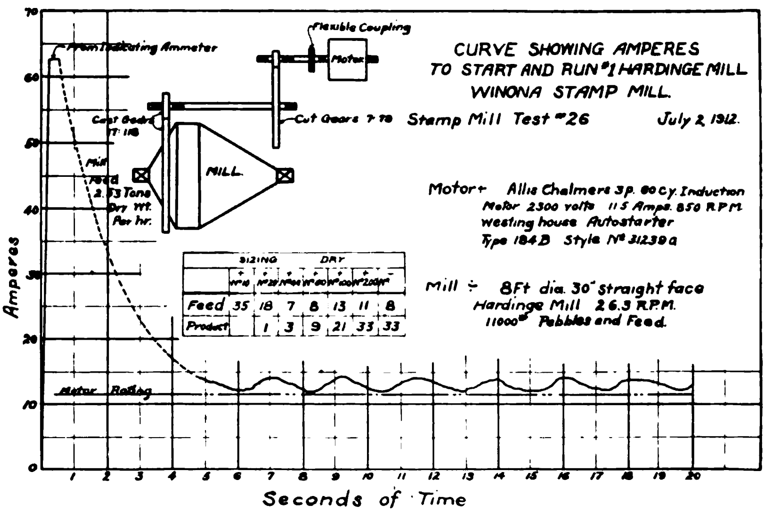


Fig. 12

supported on the sand. As regrinding increases the amount of coarse sand to be stacked will decrease.

Milling was started with one 8 by 30 in. Hardinge conical mill. During 1912 two more were installed, one a 6-ft. by 60-in. straight face and the other an 8-ft. by 18-in. straight face. For one period of January, 1912, no mill was at work. For most of the first six months two mills were in operation and for the last six months three mills were in operation. During the year about 36,000 tons of material was reground.

This figure is of course not exact but from several tests and records of time, etc., I feel sure that it is very nearly right. From the reground material 215,248 pounds of refined copper was produced. The grade of this mineral will average better than 50 per cent. The total cost of regrinding during the year was $9,697.09 or 26.93 cents per ton reground, and 4.5 cents per pound of copper recovered. With electricity costing 1.2 cents per k. w. hour, the power cost was $7,501.97 of the above total amount. Labor was $402.85 and supplies cost $1,792.27. Of the supplies, $1,235.80 was for 172,030 pounds of French pebbles and $280.68 for 19,342 pounds of silex lining. The balance was for oil and supplies incidental to repairs. The pebble loss figures nearly five pounds per ton reground as it includes the initial charge for two new mills. The pebble loss is now running a trifle under four pounds per ton reground, which is higher than usual in this district on account of the hardness of the rock.

COSTS OF GRINDING 36,000 TONS.

	Total.	Per ton Reground.	Per cent.	Units per ton Ground.
Power 1.2c per k. w. hr....	$7,501.97	20.84c	77.36	17.415 k. w. hrs.
Labor	402.85	1.12	4.15	
Supplies—				
.7184c per lb. pebbles....	1,235.80	3.43	12.74	4.78 lb. pebbles
1.4512c per lb. lining.....	280.69	.77	2.90	.537 lb. lining
Incidentals	275.78	.77	2.85	
	$9,697.09	26.93c	100.00	

The 8-ft. diameter by 30-in. straight face mill has proved the most economical in power cost per ton ground and also has the largest capacity of any we have tried. We are now installing three more 8-ft. mills which have a 36 in. straight face and we expect still greater capacity. These mills have Falk's cut herringbone gears and there is only one speed reduction, which will materially reduce the power cost. The first mill installed has a silex lining but the subsequent mills are lined on the straight face with pebbles set in grooves in steel plates. The conical faces are lined with silex blocks. Steel pebble linings have proved very satisfactory. A mill is

out of service at least four days to replace silex lining as the cement must be allowed to set. With a steel pebble lining, the mill can go into service again as soon as new plates are placed, a matter of hours only. So far, our experience shows

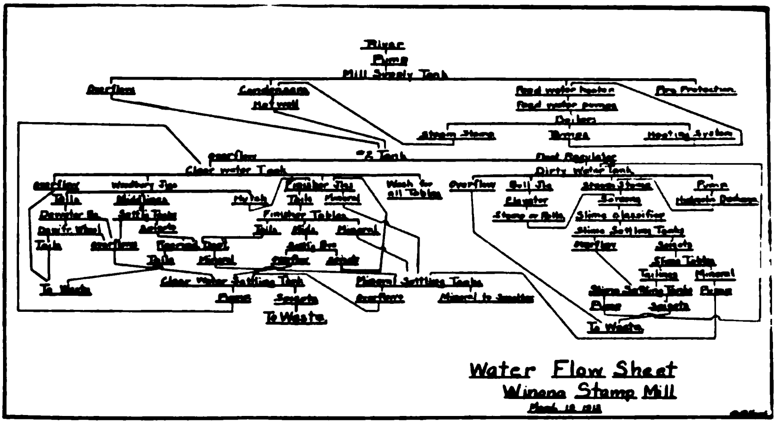


Fig. 6

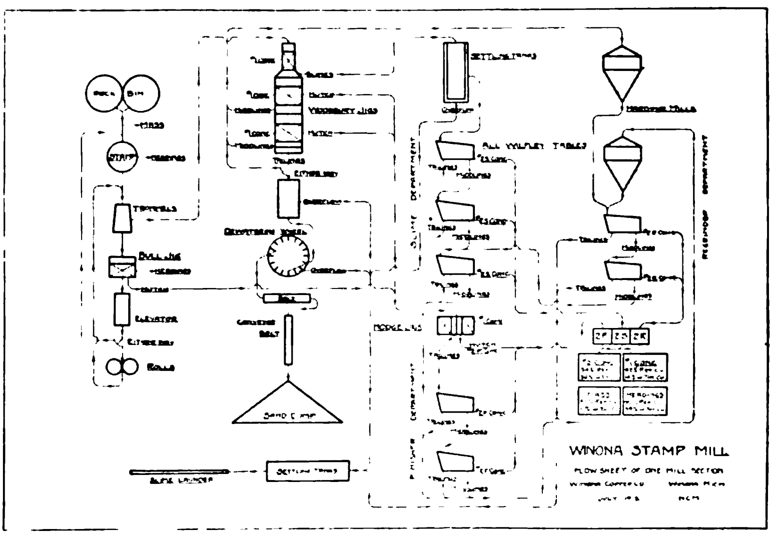


Fig. 7. Flow Sheet of One Mill Section, Winona Stamp Mill.

that the steel pebble linings are cheapest. All our new mills will be equipped with the steel pebble linings on the cones as well as the straight faces. The mill is lighted at night, prin-

cipally, by 100 candle power series Tungsten incandescent lamps on a 6.6 ampere constant current. These have been found satisfactory, the life of the lamps running above 2,000 hours.

A small lathe, drill press and power shear for cutting plate are the only power tools in the stamp mill as the mine shop is equipped for handling all other work. The detailed flow-sheet of water and material give, I believe, full information as to the manner of handling and method of operation.

The water re-used in the mill is pumped back by two separate pumps, one for the dirty water and one for the clear water. These are both centrifugal pumps, direct connected to electric motors, the "clear" water pump having a capacity of 4,000,000 gallons and the "dirty" water pump a capacity of 3,000,000 gallons. Both are regulated to suit conditions by throttling of discharge. Sand from both the "clear" and "dirty" water is simply spigoted out of the bottom of the settling tanks while the pumps are drawing from the upper part of these tanks. Following is a list of motors:

Make.	H.P.	Voltage.	Speed.	Driving.
A-C	75	2200	850	No. 1 Head Jigs, Shops & Gen.
A-C	75	2200	850	No. 2 Head Jigs, Shops & Gen.
A-C	50	2200	850	8'x30" Hardinge Mill.
A-C	45	2200	835	8'x18" Hardinge Mill.
G-E	35	2200	850	6'x60" Hardinge Mill.
Westinghouse	50	2200	500	8'x36" Hardinge Mill.
Westinghouse	50	2200	500	8'x36" Hardinge Mill.
Westinghouse	50	2200	500	8'x36" Hardinge Mill.
G-E	35	2200	600	10" Centrifugal Pump.
G-E	25	2200	600	8" Centrifugal Pump.
A-C	30	2200	850	Two Sets of Rolls.
A-C	30	2200	850	Sand Conveyor.
A-C	20	2200	1130	Tables and Pumps.
A-C	20	2200	1130	Tables and Pumps.
A-C	20	2200	1130	Tables and Pumps.
A-C	5	220	1200	Ash and Coal Elevator.
G-E	3	220	1200	No. 1 Head Valve Gear.
G-E	3	220	1200	No. 2 Head Valve Gear.
Westinghouse	5	220	1120	Tables.

The Winona stamp-mill was built on the mine to reduce operating expenses per ton by reducing transportation charges. Seventeen and one-half cents per ton was cut out of the transportation charge and the following items were added:

Stacking sand	1.2c per ton stamped
Transportation on the mine	3.6c per ton stamped

This still leaves an important net saving due to location of mill on the mine. The unit costs given are necessarily high due to the small tonnage handled, namely, 181,184 tons for the year 1912. The detail of these costs follows:

Cost of belt and conveyor idlers, about $4,000 erected; life 40 months; cost per month	$100.00
Power at the rate of 8 k. w. at 1.2c per k. w. hour	60.00
Attendance	10.00
Oils, etc.	10.00
	$180.00

Or 1.2 cents per ton on 15,000 tons stamped. These will of course be reduced materially with increased tonnage handled. Of the power used, at least two-thirds is in friction.

In addition, the following interest and depreciation charges might be listed against this operation:

Cost of conveyor bridge and towers, fully equipped with belt and machinery	$12,000.00
Interest at 6 per cent	720.00
5 per cent depreciation on $8,000 of this amount	400.00

The depreciation of the other $4,000 is already accounted for in the working cost.

Pumping costs should not be increased over similar costs with a stamp-mill on Lake Superior as while the water rehandled is pumped with less efficient machinery the head against which it is pumped is very materially reduced. The pumping cost taken from our cost sheet for the year 1912 is 2.3 cents per ton stamped. This is materially higher than the usual figure on Lake Superior, owing, principally, to the smaller tonnage stamped.

There is undoubtedly considerable gained by the concentration of all operations at the mine. Some of this gain cannot be expressed in cents per ton. During part of the month of March, 1913, railroad service in Houghton county was very much hindered by heavy storms. Several of the mines were shut down temporarily and freight train service, at least, was cancelled for days at a time. Neither the Winona mine nor the mill was delayed on this account as our tracks are comparatively short and easily kept clear of snow.

SAFETY IN THE MINES OF THE LAKE SUPERIOR IRON RANGES.

BY EDWIN HIGGINS, IRONWOOD, MICH.*

It is not the purpose of this paper to go into a detailed discussion of safety in mines, or to submit a set of rules that will eliminate accidents. No living man, whatever his occupation, is immune from accidental bodily injury. Accidents cannot be eliminated; they may, however, by the exercise of care and vigilance, be kept within certain reasonable limits.

As a result of visits to many of the iron mines of the Lake Superior region, for the purpose of studying conditions and possibly learning something as to the causes of accidents, some impressions have been gathered that might be of interest. In this paper, certain existing conditions will be discussed, and some suggestions offered, not in a spirit of criticism, but with a view to emphasizing some of the features of safety work.

In general, interest in the work is high. A great deal of money is being spent in safety devices and other means looking to a reduction in the number of accidents. Except in a few cases, the mine officials are doing all in their power to accomplish this end. The seed of "safety first," sowed some years ago on the iron ranges, has become firmly rooted.

It seems natural in a discussion of safety to turn first to the causes of accidents, for the remedy of any evil lies in removing the cause. Few accidents may be charged to any one direct cause; most of them are due to a combination of circumstances or conditions. For example, a man is hurt from

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*District Engineer, Michigan-Minnesota-Wisconsin Division, United States Bureau of Mines.

a fall of ground. The direct cause of the injury here was the falling of a section of ground. However, the falling of the ground might have been due to the failure of the miner to pick down the back; the timbering might have been insufficient or improperly placed; possibly the miner was trying for "easy dirt" and was taking a chance; or the working place might not have been carefully inspected. In turn, any or all of these conditions might have been due, indirectly, to a demand for more ore production, either by the management or by an over-ambitious captain or shift boss.

A man is crushed between a post and a motor or car. This accident might have been due to the fact that in laying the track insufficient clearance was allowed for between the cars and the post; or to the lack of a bell on the motor; or to the carelessness or inexperience of either the motorman or miner who was hurt.

In a broad sense it seems reasonable to assume that safety in and about the mines is closely related to and dependent upon the following conditions and elements:

Rapidity of production of ore.

Labor conditions.

Accident preventive measures and devices.

The Human element.

Rapidity of Production of Ore.

Forcing the production of more ore than can be supplied under normal working conditions doubtless tends to increase the number of accidents per man employed in the mine. A comparison of accident and production records will show this to be true in many cases. When the working places are overcrowded with men and machinery and the mine equipment is being worked beyond its capacity, there is a tendency for the work to go with a slam and a bang that allows little chance for anyone who happens to get in the way.

The demand for over-production might come from the management or officials; or, as is often the case, it might result from the spirit of rivalry that exists between some

captains or shift bosses. To a certain extent, the belief is still prevalent that a man's worth is gaged by the amount of ore he produces. There are doubtless other causes that tend to spur the miner on in his work; the result in most cases is to make him less careful of his safety. The elimination of undue haste in all departments of mine work will tend to reduce accidents.

Labor Conditions.

A scarcity of labor means that there are a correspondingly smaller number of experienced men available. It follows that green men must be employed in the mines and that incompetent men must be kept at work when they should be discharged. Such conditions are productive of accidents. The green hand, being unfamiliar with his working place, machinery and tools, does not know what to do in an emergency. Usually he does the wrong thing and receives an injury.

Where an entire district is effected by a shortage of labor it is practically impossible for any one operator to remedy permanently conditions at his property. He may secure men from outside of his district but this is expensive and is not a lasting or satisfactory remedy.

Accident Preventive Measures and Devices.

No attempt will be made to describe the many safety devices and methods in use. The subject of accident prevention will be discussed in a general way under the following heads:

Machinery, Tools and Appliances.
Timbering.
General Conditions in and About the Mines.
Handling of Explosives.
Fire Prevention and Protection.
Rules and Regulations.
Inspection.

Machinery, Tools and Appliances.

Usually the master mechanic is held accountable for the condition of all machinery. He must be certain at all times that his machinery is in safe condition for use, and that all

exposed parts, such as fly wheels, belts, pulleys, etc., are so covered that men cannot be caught and injured by them. This applies to underground as well as surface machinery, although the care of the underground machinery usually comes under a different man. Some companies make it a rule, where there is a choice, to avoid the use of machinery, devices or appliances that offer a chance of pinching or mangling the limbs of employes. In general, it was found that much has been done towards protecting men from exposed parts of machinery.

Hoists, especially those used for handling men, should be provided with an automatic cut-off to prevent overwinding. Cables should be carefully inspected at frequent intervals and the ends cut at stated periods. Cages for handling men should be provided with safety dogs and doors. Safety dogs should be tested at least once a month by dropping the cage; there are various well known methods of doing this. Although nearly every cage inspected on the iron ranges was equipped with safety dogs, it was found that less than 40 per cent of them were tested at regular intervals; many never had been tested. A safety dog is not safe unless it is known to be in perfect working order.

Where electrical haulage is used underground, the assistant, or "swamper," on the motor is often injured by having his legs crushed or mangled. Accidents of this nature are due to the fact that no place is provided on the rear of the motor for the "swamper" to ride in safety. At one mine this class of accident became so common that motors were provided with a place for the "swamper" to sit, so that his legs are protected the same as are those of the motorman on the front end.

All electric feed wires should be well insulated and carefully laid to prevent short circuiting. Trolley wires should have protection, especially at ore chutes. The common mode of protection is to provide, where the trolley passes in front of ore chutes, inverted troughs or launders of square or V-

shaped section; or to secure, on each side of the trolley, round timbers from 5 to 8 in. in diameter.

Telephones underground often play the part of a safety device. They should be installed in every mine.

TIMBERING.

From a safety standpoint, the proper timbering of working places is of great importance. In most of the accidents happening from insecure or improperly-placed timbering, it has been found that the work has been done, or left undone, by an inexperienced man. The green man is most likely to overlook one of the first principles of proper timbering, viz: that of using sufficient blocking between the timber and the back. This has been the cause of a great many accidents. Under the head of improper timbering many conditions could be referred to that may result in injury to the miner, but it seems unnecessary to go further into this subject. The remedy for such conditions, especially where green men must be employed, is a closer inspection of all timbering. This remedy has brought forth good results in several instances known to the writer.

Another plan that has been adopted with good results is to timber every place where there appears to be the slightest chance of a fall. In one large mine a close study of accident reports brought out the fact that falls of ground, resulting in injury, were occurring in rock drifts where it was thought that timber was entirely unnecessary.

It is the rule in many of the mines for the captain or someone else to either climb, or make a slow trip by cage, through the shaft at frequent intervals, closely inspecting guides and timbering. Such trips do not consume much time and should be made every day.

GENERAL CONDITIONS

Handling Men—In order to avoid accidents that might result from the sudden disability of the hoisting engineer, two men should be on the hoist when lowering men into or hoisting them out of the mine.

Miners are often hurt by crowding too close to the shaft when coming on or going off shift. The usual effective method of preventing accidents of this kind is to provide some kind of enclosure around the shaft collar and underground stations, into which men may be admitted in limited numbers.

Traveling Ways—Every mine should be provided with at least two outlets with ladderways in good repair. If the distance is not too great the men should be made to pass through the second outlet from time to time in order to familiarize them with the way.

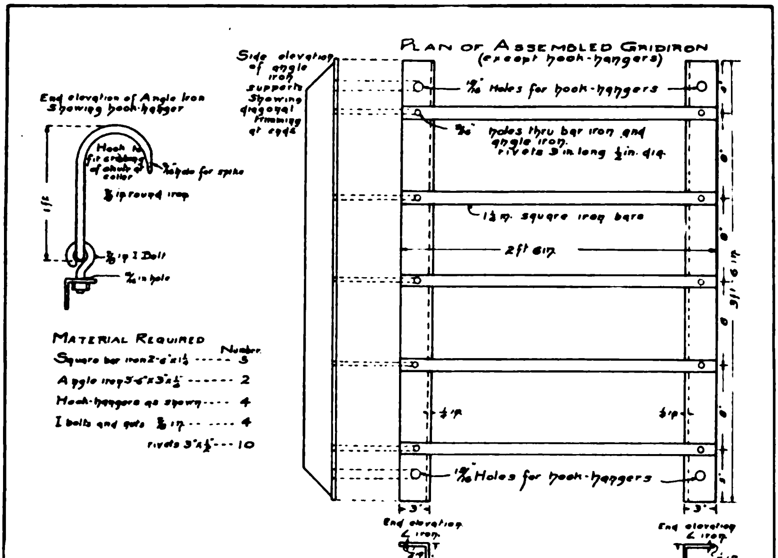
All traveling ways underground should be kept as clear of rubbish and old timber as possible. Timber with jagged edges or with nails protruding, powder and candle boxes, in short, trash of any kind, are sources of danger when allowed to collect in traveling ways. A small piece of wood has been known to derail a motor or tramcar; men often are caught between a derailed car and the timber. A man may trip over a slight obstruction, fall and receive a serious injury.

In repair work in haulage drifts, neither old or new timber should be left laying or standing any longer than is absolutely necessary. Men have been crushed by motors and cars because the way was so full of obstructions that they could not escape.

Protection of Open Places—Every place into which it is possible for a miner to fall should be protected in some manner. This refers to gates or fences for shaft collars and stations, doors for manways, bars or fences for ore chutes, and fences for dangerous abandoned places.

Where cribbed ore chutes are used, as in the soft ore mines, there seems to be a tendency, due to the weight of the ore in the chute and the working of the surrounding ground, for the cribbing to settle and become distorted. Under such conditions it is important to keep the collar of the chute in repair. In the course of time the iron bars used to prevent men from falling into the chute will settle with the cribbing. While bars four or five feet below the collar of the chute

may prevent serious falls, they are as much a source of danger as they are a protection; a man falling upon them is liable to very serious injury. To remedy this condition, a special grating is used at one mine. It consists of 1-in. square iron pieces riveted loose to angle-iron end pieces. The square iron pieces are placed 8 in. apart and the grill so formed is supported to the chute collar by means of four round iron hooks, 1 ft. long, bolted to the angle-iron end pieces and passing over the top set of cribbing. In the end of the hook is a hole



SKETCH OF GRID-IRON FOR PROTECTION AT COLLAR OF ORE CHUTE.

through which a spike is driven to secure the hook to the cribbing. The device always hangs 1 ft. below the top of the chute; it will adjust itself to any distortion of the cribbing. This device is shown in an accompanying sketch.

Open and dangerous places should be further protected by the use of ample lighting. This is simple on main levels where electric lamps are used. Great care should be used, however,

where it is necessary to employ some type of torch or other open light, especially if there is much timber in the immediate vicinity.

Ladderways and Ladders—For shafts, ladders placed in an inclined (forward) position, with platforms, or sollars, not more than 24 ft. apart, are recognized as safer than the continuous ladderway without platforms. Ladders should project at least 3 ft. above platforms, or there should be a hand hold of some description provided just above the platform.

Ladders, wherever used, should be placed about 3 in. out from the opening in which they are hung, and should be securely fastened. The spacing between rungs should be uniform throughout and not more than 12 in. from center to center. Broken or badly bent rungs should be immediately replaced. Three types of rungs are in general use—round iron bars, wood, and iron pipe. Wood rungs present a better hold for both hand and foot. They are subject to rot or easy breakage from falling rock or other material, and hence are not as serviceable as iron. Solid iron rungs are good, but when they are bent, especially in a wet mine, they make it easy for the miner to slip. Rungs made from discarded 1-in. iron pipe are cheap and effective; being larger, they present a better hand and foot hold than the solid iron rung. For the protection of rungs, as well as human life, the top of every ladderway should be kept clear of loose rock. Careful inspection and repair of ladders will tend to reduce accidents from falls.

Tracks—Some importance is attached to the proper grading of tracks, from a standpoint of economical work, and because pushing cars up too steep grades may be the cause of injuries in the nature of strains. In the haulage ways, especially in rounding curves, ample room should be provided for men to stand to avoid being crushed between the car or motor and the timber. A great many accidents happen from this cause.

Tracks should be kept clear of all rubbish, especially pieces of wood and rock.

Signs—Various kinds of signs are in use in many of the mines. This is a subject that is worthv of serious consideration. The most useful signs appear to be the following: Something to call attention to places where explosives are stored; something to indicate dangerous places, such as abandoned open stopes, places over which work is being done, etc.; signs pointing the way to the different outlets of the mine. The latter should be more numerous where the vein is wide and the workings intricate. There is a great need of a universal danger sign, something that by constant use will eventually become familiar to men of all nationalities.

HANDLING OF EXPLOSIVES.

For underground work it is the general practice to use various grades of dynamite, such as straight dynamite, and the low-freezing, ammonia, gelatin, and granular dynamites. Explosives are fired by means of fuse and detonator, except in shaft sinking, in which it is customary to use an electrical firing device.

In nearly all cases the explosive is carried into the mine in the original box, usually with the cover on, but in some cases with the cover removed. The best practice seems to be to remove the cover after the explosive is received underground, using a wooden mallet and wedge for the purpose.

Storage Underground—Explosives are stored underground either in a central magazine or in boxes kept near the working places. The chief factor in determining the best method of storage is the system of mining in use. Under different conditions either method of storage may be best. In any event, no more than 48 hours' supply should be kept underground at any one time.

Powder houses should be removed from working places and traveling ways. Those cut out of the solid rock, supported where necessary by steel and concrete, are safest. They should be in charge of a powder man who shall deliver explosives to the miner on written order only. In several mines the practice is followed of requiring the shift boss to make out

and sign the order for explosives. It is claimed that this method is both economical and safe, as it prevents the miner ordering too much explosive, at the same time eliminating the habit of leaving sticks of explosives lying around promiscuously. The powder magazine should be electrically lighted and no one should be allowed to enter with an open light of any kind. A good precaution is to place a fuse in the line leading to the powder magazine in order to prevent the explosion of an incandescent lamp in case the current should rise suddenly.

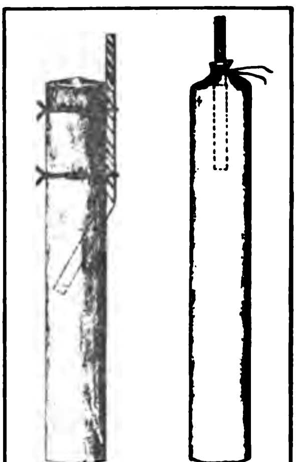
Fuse and Detonators—The powder man should have charge also of the detonators and fuse and these should be kept in a room at least 50 ft. from the explosives. The duties of the powder man may include the cutting of the fuse and the crimping on of the detonator, for which latter purpose a crimper should be supplied. There are still a few miners left who will crimp a detonator with their teeth.

Thawing—Thawing is variously performed. In cases where low freezing dynamite is used no means is provided for thawing. Some magazines are heated by steam coils and kept at a certain temperature. Thawing devices heated electrically or by steam pipes are used, as well as different types of hot water thawers. Electrical heaters require careful planning to prevent dangerous conditions due to short circuits or overheating. Only in a few cases was the dangerous practice of thawing in contact with a heated metal surface observed. Where steam is used for thawing it should be used under low pressure; exhaust steam from some source may be available. The practice of carrying sticks of explosives in the clothing in order to thaw them from the heat of the body should be prohibited.

Carrying Explosives—In carrying explosives from the magazine to his working place the miner has been observed to make up a bundle of a dozen or more sticks and tie it up with fuse; or he may carry the explosive loose or in a cloth sack. Obviously, the latter method is safest, because the explosive

is better protected and is not likely to be lost. One objection to tying up a bundle with a length of fuse is that the fuse is very likely to develop a defect from such treatment.

Loading Detonator Into Primer—There were few mines visited in which any regulation method of attaching the detonator to the primer was followed. In practically all cases the superintendents and captains knew that certain methods were to be preferred; the difficulty seemed to be in causing the miners to adhere to rules. Any method of performing this operation that allows the detonator to protrude from the primer, or the formation of sharp angles in the fuse, should be prohibited, as they give rise to premature explosions and missfires. Either of the methods shown in the accompanying sketch is both safe and efficient. A skewer of wood or brass should be used for punching the hole in the cartridge.



DETONATOR AND FUSE IN PRIMER

Tamping—From a standpoint of both safety and economy, all explosives should be well tamped. For this purpose damp clay may be used; the tamping stick should be of wood.

Missed Holes—In handling missed holes much care is generally used, although in some mines no set rule is followed. Usually some form of report is used whereby the

captain or shift boss of the oncoming shift is notified of the missfire. The shift boss locates the hole, removes the tamping, then inserts and fires another primer. In locating the hole the shift boss may be guided by the experienced miner, who can designate, in many cases, the charge that has failed to explode from the sequence of the reports. No set rules can be laid down for handling missfires. It may be said, however, that at least one hour should elapse before anyone is allowed to return to the hole; that great care should be observed in locating the hole and removing the tamping; that the charge should never be gouged out with a metal scraper; and that no attempt should be made to pull the fuse and detonator from the hole. There should be some place for posting or delivering a printed form for the attention of the captain or shift boss of the oncoming shift. This form should be so filled out as to draw attention to the exact place where the missfire has occurred, and the number of holes missed.

Black Powder—For blasting on surface, as in open pits, various classes of black blasting powder are used. Care should be used in the storage and opening of the powder canisters. Loading should be done by careful and experienced men. The safety precautions in this class of work are well known and will not be discussed here. It seems only necessary to mention the fact that constant vigilance is essential, for even men of long experience in handling powder will in time become careless and overlook the simplest rules for safety.

Rules and Blasting Signals—Rules and regulations concerning the handling of explosives should be printed and posted in proper places. Such placards should contain a few short and concise statements regarding the chief dangers in handling explosives.

Miners should never be allowed to blast a hole, or even a plug shot of half a stick of dynamite, without giving the customary warning. The strict enforcement of this rule will prevent accidents.

INSPECTION.

Safety inspectors, or committees, are to be found at many of the mines, but a great number of them still depend upon the captains and shift bosses alone to keep the mine in a safe condition. The mines at which some form of inspection was provided showed the good results of the work. Constant contact with certain conditions may cause even the careful captain or shift boss to overlook the dangerous features.

FIRE PREVENTION AND PROTECTION.

While generously provided in few cases and moderately in most, fire protection was found entirely lacking in some of the mines. As a protection to life and property every mine should be provided with some means of preventing and fighting fires, both on the surface and underground. The aim should be to remove, as far as conditions and necessity will permit, the causes of fires; and to provide the necessary equipment for attacking quickly any fire which may originate. The following may be set down as the causes of metal mine fires:

Careless use of lights underground, in shaft, or at shaft collar.

Defective electric wiring.

Spontaneous combustion from friction in shaft rollers or underground machinery.

Spontaneous ignition of combustible rock.

Dropping lighted paper, candle or other material in ore chutes.

Building small fires underground for any purpose.

Dumping ashes into open pits connected with underground workings.

Careless use of matches.

Incendiarism.

Smoking in timbered places underground, in shaft, or at or near shaft collar.

Sparks from surface engines of any kind, or from surface fires.

Allowing combustible rubbish to collect underground.

By studying the causes of mine fires and some of the well known preventive and protective measures, many of which are embraced in the following suggestions, an efficient system may be worked out for almost any conditions.

Do not place wooden structures close to the shaft collar. Have as little wood construction as possible around collar; steel headframes with steel and concrete construction to a depth of 25 ft. below the collar are safest. Sprinkle dry shafts. In all shafts use care in electric wiring; keep rollers well oiled; cover steam pipes, especially if laid close to timber; do not allow candle snuffs or other open lights to be left on timber.

In shaft and pump stations use as little wooden construction as possible; provide steel and concrete where support is necessary. Do not allow combustible material of any kind to collect; do away with open lights as far as possible; use care in electric wiring; provide separate receptacles for clean and oily waste; do not place machinery close to timber; do not spill oil on timber. If conditions do not warrant steel and concrete construction, at least break timbering connecting pump station with shaft, using steel and concrete if support be necessary.

Do not allow dry wood, powder and candle boxes, paper, hay, waste, manure, or other combustible material, to collect anywhere underground.

Provide a fire patrol for all timbered parts of mine.

Do not store lighting or lubricating oils in great quantity underground, especially near timbered places.

Provide one or more chemical fire extinguishers at or near the shaft collar, at every station, at powder house, and in timbered drifts or crosscuts distant from the shaft.

Provide one or more water plugs or connections, with several lengths of hose, at or near shaft collar and at stations. Water may be supplied underground from pumps, water column, or by separate line from surface. A shaft sprinkling

device is useful under certain conditions. In tapping water column it may be necessary to use a special pressure reducing valve.

Make air line convertible into water line.

Have a barrel of water and buckets at shaft stations.

Provide dry fire extinguishers, such as sand, salt or powdered limestone.

Arrange for the control of ventilation through the use of doors.

Provide air tight fire doors for isolation of parts of mine.

Make rules for fire prevention and enforce them.

Have fire drills and a pre-arranged plan of action in case of fire.

Provide oxygen breathing apparatus.

Provide fire signals.

Arrange to notify miners in case of fire and be prepared to get them to surface promptly.

Before leaving this subject, it is desired to draw attention to the use of candles for lighting underground. This article has probably been the cause, directly or indirectly, of more mine fires than any other known agent. It is notable that the candle is fast being replaced by the carbide lamp on the iron ranges. No mine, especially if it be dry and timbered, is safe from fire while candles are permitted below the collar of the shaft. Carbide lamps, while they are not an ideal lamp for the purpose, seem to be the best and safest device at present known for lighting underground in metal mines. Compared with candles, they consume less oxygen, give a brighter light, are at least half as costly, and present little danger of setting fires underground, chiefly because they are not hung on dry timbers and are carried out of the mine when the miner goes off shift. It might be mentioned also that the carbide lamp, because of its greater brightness of light, affords a better chance for locating loose pieces of rock in the back, and for seeing obstructions under foot. From a standpoint of fire prevention, there is great need of some lighting device for

underground that has an enclosed flame; at the same time it must be simple, inexpensive and effective. Portable electric lamps (storage battery) are now coming on the market for use in coal mines. Lamps of this type present advantages for use in metal mines, but they must be simplified and improved before their adoption is likely to become at all general.

Oxygen Breathing Apparatus.

By the use of oxygen breathing apparatus, the wearer is enabled, without inconvenience, to perform hard labor in an atmosphere containing smoke, fumes or poisonous gases. This device is an important part of the equipment for fighting underground fires and may be instrumental in saving life where men are overcome or lost in gas-filled mines. The apparatus should be kept clean and should be tested at frequent intervals to make sure that it is ready for instant use. In storage, it should be protected from steam, hot air and dust. A sufficient supply of oxygen should be kept on hand at all times.

There should be two or more trained crews of five men each. If a crew consists of three or even four men and one of these men should meet with an accident, there is great danger that the two or three remaining men may not be able to carry him out of the danger zone. The leader of the crew should be cool and deliberate and should exact absolute obedience from every man under him. He should take every precaution for the safety of his men, thoroughly testing every apparatus before going underground in case of fire.

For a more detailed discussion of this subject the reader is referred to Miner's Circular 4, "The Use and Care of Mine Rescue Breathing Apparatus," by James W. Paul, published by the United States Bureau of Mines, Washington, D. C.

First Aid to the Injured.

From the standpoint of safety, first aid to the injured, where practiced, suggests to the miner that he is liable to injury; it protects the miner who has received an injury, and prevents simple injuries from developing into something more serious, thus shortening periods of disability.

In the generally accepted sense, first aid to the injured does not contemplate the production of physicians after a few lessons—or any number of lessons. Its purpose is to give temporary relief, by the simplest possible means, until the injured man can be taken to a physician or hospital. The study of first aid teaches what not to attempt, as well as what to do. As taught by the American Red Cross Association, the United States Bureau of Mines, and other institutions, a man of no schooling may become as proficient in the work as the man of highest education.

The larger companies operating on the iron ranges, and many of the smaller ones, have taken up the work of first aid to the injured. In some localities the work is well organized and is doing a wonderful amount of good. Most operators and physicians are firm believers in the efficiency of the work, both from a humane and from an economical standpoint.

It is suggested to any who have not given this subject serious consideration that they look up the records of what first aid has accomplished in the coal fields of the United States in recent years; or better still, obtain records of what the work is doing on the iron ranges. Reports from one large hospital show that cases of infection have been reduced 50 per cent since the introduction of first aid work.

Sanitation and Ventilation.

Sanitation and ventilation in mines are closely related to safety. A miner's general health is more valuable to him than a sound leg, arm or finger; and he will do more efficient work and be less liable to long disability when injured, if his general health is good. Unsanitary conditions in the mine, coupled with an insufficient supply of fresh air, will sooner or later show their effects upon the strongest man.

Rules and Regulations.

Practically all of the mine operators believe in the use of rules and regulations. This belief is exemplified in some cases by the official who at least posts a notice against smok-

ing in certain places, or one refusing admittance to the mine or plant; passing through many gradations up to the official who believes in the printing of rules and regulations in eight or ten different languages. There can be no question as to the necessity of rules; and there seems to be no suitable method of reaching the men of various nationalities without printing these rules in numerous languages.

The important point, often difficult to attain, is the enforcement of these rules and regulations. The only satisfactory method of enforcing rules is to discipline, and finally discharge, offenders against them. Unfortunately, labor conditions are not always such that this course can be followed.

The Human Element.

The human element enters into every angle of the safety problem. Rules may be provided, safety devices and precautions may be provided in the greatest abundance, and every preventive measure known to science may be brought into use; but they will not avail to reduce accidents to the minimum if the safety spirit is lacking in the officials, the captains, the shift bosses and the men under them.

For instance, such an experience as the following is not uncommon. An official goes underground and finds certain dangerous conditions existing, against which there are strict and clearly worded rules. These rules might not have been observed for any one of several reasons. The captain might not have been sufficiently impressed with the "safety first" idea; the captain might not have educated his shift boss sufficiently; or either the captain or shift boss might have been of that type who cannot adjust himself to ideas of safety as against ore production.

The remark has been heard that this or that captain or shift boss could not be brought to give serious attention to matters of this kind; that they were too valuable to discharge and would doubtless come around to the changed conditions later. In cases of this kind it seems to be a question of which man is the most valuable, the man who gets out ore without

injury to his men, or the man who produces a greater tonnage at the cost of human life. This is a question that may be studied either from a humane or from an economical viewpoint.

Unless the mine official is of the firm belief that safety pays, little may be expected from the men under him. The best results seem to be forthcoming from the mines where the slogan "safety first" is strong with the officials, and by them is made to permeate every department until it finally reaches, through the captains and shift bosses, the men behind the drill, the pick and the shovel.

It is the rule on the iron ranges to find the mine officials greatly interested in safety, and the same may be said of the captains. However, the general run of shift bosses do not present a fertile field for the safety seed; either that, or the seed is improperly sowed. This does not refer to all shift bosses, for there are many safety enthusiasts among this class; nor does it mean to imply that a shift boss would willingly or knowingly put a man in a dangerous position. The idea that it is desired to bring out is that, in general, the safety spirit is high with the average official, and most of the captains; but when it reaches the shift bosses it begins to die, and by the time it comes down to the miner it is almost dead. The average miner resents suggestions for his safety. He will take care of his dinner pail and he will be careful to get all that is coming to him from his contract, but he will not take the necessary precautions to safeguard his life. Of course, there are some who are careful.

The above statements are made after a close study of this particular feature of safety work in many of the mines. They lead up to what the writer believes to be of the utmost importance in the prevention of accidents, namely: That far more good may be accomplished by educating and securing the co-operation of the man underground than by the use of safety devices or measures of any other kind. Safety devices are good and they are absolutely essential for protecting

the miner; if they could be coupled with a mine full of men whose thoughts were for their safety, then conditions would begin to approach the ideal. The method of securing this co-operation is the problem of the management, and the problem is not the same in every mine. Schemes that will work out well in one mine might fail under widely different conditions.

ORGANIZATION AND CO-OPERATION.

In many of the mines the captains and shift bosses are looked to for the reduction of the accident list. Another class is made up of those mines which have one or more safety inspectors. Still another class embraces the mines of the larger companies that maintain safety departments and spend a great deal of time and money looking to the welfare and safety of the man in and about the mine.

Of the schemes for securing the co-operation of the captains and shift bosses there are none that seem to bring better results than the monthly or semi-monthly meetings at which accident reports are read and the accidents, with possible suggestions as to how they might have been prevented, discussed. In some cases rivalry is stirred up amongst the shift bosses by offering small monthly prizes to the boss whose record for injuries to men is the cleanest.

The writer is of the belief that a yearly cash bonus to shift bosses, based upon the number of men injured (or the number of days disability resulting therefrom) and killed, will be effective in reducing accidents. At first thought this proposition might not be attractive. However, let us start with the premise that in a certain mine the shift bosses are not as careful as they should be—and this applies practically to all mines. There are, say, ten shift bosses. You appeal to them from the humane standpoint; possibly three will be deeply interested, three more moderately so—the remaining four are thinking of something else. And so it will be if you talk of prizes of any kind, until you mention, say $500 as a yearly bonus; there are then exactly ten shift bosses intensely in-

terested in your conversation. Consider the number of broken fingers it will take to cost $500 in compensation.

The cash bonus is a suggestion; the plan in detail must be worked out with careful regard to the conditions under which the men work. One objection that has been heard is that conditions in one place might be more dangerous than in another, in this way presenting difficulties that might arise under any bonus system. It would seem that in the course of a year conditions would change sufficiently to equalize risks of injuries. As a matter of fact it is often found that more accidents happen in places that are supposedly safe than in those that are known to be dangerous. In this connection, attention is directed to the fact that certain companies have brought about great improvement by offering cash prizes to miners for gardens and clean premises.

During the past six months committees or associations have been organized in various districts on the iron ranges. Membership is made up of mine officials, captains, shift bosses, engineers and others interested in safety work from all operating properties of the district. The purposes of the organization are, through co-operation, to promote welfare, safety in and about the mines, social intercourse, first aid to the injured and rescue work, and sanitation. The co-operation is to be effected by regular meetings, at which these various subjects will be discussed, and by visits to the different mines. Several of these organizations show signs of becoming permanent and powerful institutions.

The methods of securing the co-operation of the miner are through the posting of warnings of different kinds, the printing of rules and regulations, the posting of newspaper accounts of mine accidents with illustrations showing how men are injured, the formation of inspection committees of miners, and through personal contact of the officials, captains and shift bosses. These methods are more or less productive of results, but there still exists a woeful lack of willing co-operation among the miners. Just how this condition may

be improved is a problem, the solution of which will do much for the cause of safety in mines. Suggestions along these lines may be obtained through a study of the methods in use by many of the large industrial organizations of various parts of the United States.

Conclusions.

The reader, if he has the patience to go carefully through this paper, will doubtless make the mental note that there is still much to be written on the subject of safety; that the suggestions made are mostly old and well known; or that he does not agree with the writer on some points. It is hoped that these very faults might have the good effect of suggesting the points that have been omitted; in stirring someone to adopt a suggestion that he has neglected in spite of its age; or in bringing out, through discussion, a better way to accomplish some of the objects outlined.

More than this, it is hoped that by giving publicity to the subject of safety in mines, more converts will be made for the cause. The protection of our fellowman is a duty that we owe to ourselves and to mankind. If there is no appeal in the humane side of the question, study it from a standpoint of dollars and cents, for safety in mines pays, first, last and all the time.

WHAT OUR NEIGHBORS CAN DO IN MINING IRON ORE.

BY DWIGHT E. WOODBRIDGE, DULUTH, MINN.*

Lest we forget that there are others in the United States than we of Lake Superior, who are doing things in iron mining, and other places than the Mesabi range where iron is mined, and where records are made, I want to call attention to a few items from my note books. These items were gathered recently in work for the United States Government, as consulting engineer of the Bureau of Mines.

I found that in the brown ore regions of Alabama, they are mining an average of 7 or 8 cu. yds. of material for every ton of 50 to 52 per cent ore, dried analysis, that they save. The Weems mine of brown ore, in the Rock Run district of Alabama, has mined 2,200,000 yds., and has secured 300,000 tons of ore; one ton to every 7 yds., plus. A company in that vicinity was mining, at the time of my visit, 15 yds. to get 1 ton. All this material has to be mined from the ore bank, transported to the washery, washed and loaded on cars, and the cost figure for this operation of 15 yds. to the ton was about $1. Companies like the Republic Iron & Steel Company are buying brown ore of a guarantee of 45 per cent, dry, at $1.35 a ton f. o. b. cars. The Roane Iron Company, of Chattanooga contracts for brown ore at $1 a ton when No. 2 foundry iron is selling at Birmingham at $7, and a 5 cent premium for every dollar added to the price of pig iron until it has reached a maximum cost of $1.50. That would make the Roane Company's brown ore cost it, now, about $1.20. This is for a ton of 2,268 pounds, which is a

*Consulting Engineer.

weight used, I believe, nowhere else. The Woodward Iron Company figures its brown ore costs at about $0.821 at the mine.

In the Clinton ore district of New York state, where the iron content of the ore is about 40 to 45 per cent dry, they are removing an overburden that is from 10 to 20 ft. thick, half of it consisting of a hard limestone which must be blasted before removal by the shovels, in order to get at a thickness of about 2 ft. of ore. This ore dips flatly into the earth, and they are now trying to figure out how they will be able to follow the ore to a depth of 500 ft. vertically, underground. This will mean a distance of 4 or 5 miles from the outcropping. This Clinton ore district of New York state, about which we hear very little, and from which but a trifling quantity of ore is now taken, is estimated to contain not less than 500,000,000 tons of merchantable ore.

An underground mine in Etowah county, Alabama, on the Clinton formation, is successfully producing a 45 per cent ore from a seam that averaged, at the time of my visit, 25.5 in. thick. Ore is successfully mined in this property to a thinness of 14 in. Miners get 55 cents a ton for ore in faces 36 in. thick, with a premium on thinner seams and a penalty on thicker. At this mine the ore is trammed underground in main galleries 48 in. high by "jennies" whose ears seem to have been cropped to fit the openings, is hoisted to the main tunnel level on platforms up an incline, is trammed out to surface by mules and run through a crusher and over a picking belt to remove slate, and the picked ore is then let down a long incline to the railroad track. The cost of all these operations was averaging, at the time I saw the mine, about $1.40 per ton of picked ore, this figure including all overhead costs as well as transportation to the furnace and amortization.

Generally accepted figures on the tonnage of Clinton ores available in that part of Alabama between Birmingham and the suburb of Bessemer have been for about 800,000,000 tons of the better grade, or "self-fluxing" ore. But by virtue of a

drill hole sunk last year by Cole & McDonald, of Duluth, this figure should be doubled, as to probable ore. This drill hole went vertically 1,902 ft. to the top of the "big seam" of Clinton ore, that outcrops 14,500 ft. away. At the outcrop of the "big seam" it shows a thickness of some 12 ft., but at this point some 3 miles back from the outcrop, and 1,900 ft. deep, the ore shows a combined thickness of 15 ft. in two seams parted by 2 ft. of slate. It is probable that there is as much good ore between Birmingham and Bessemer, an extreme length of about 20 miles, as there is on the Mesabi range, and that there is about as much merchantable ore of the Clinton hematites in Alabama as of all merchantable ores in the Lake Superior region. And lest we forget the comparative value of these ores, let us bear in mind that a 40 per cent hard Clinton hematite of Alabama, is as good for furnace use as a 50 per cent Mesabi hematite, on account of its comparative freedom from moisture and its high percentage of carbonate of lime.

The distribution of brown ore banks, throughout the United States, is far wider than that of any other type of iron bearing material. These banks occur in the states of Vermont, Massachusetts, Connecticut, New York, Pennsylvania, Maryland, Georgia, Tennessee, Alabama, Kentucky, Missouri, Texas, Iowa and Wisconsin. They are mined in Pennsylvania, Virginia, Tennessee, Georgia, Alabama, Texas, Iowa and Missouri; chiefly in Alabama and Georgia. That they are some factor to be reckoned with in the future, may be gathered when I say that there are areas of these banks in Alabama alone, covering 7,000 square miles. No estimates of tonnages that are worthy of credence have ever been made, and it is impossible to make such estimates, on account of the uncertainty of the deposits. It is a common saying in the south that no man can see into a brown ore bank, further than the end of his pick. But, it is not unlikely that the deposits of these ores in the southern states of Virginia, Tennessee, Georgia and Alabama, will be found ultimately to be of enormous quantity.

In the Clinton ore mines of Birmingham some of the mining companies pay their miners on the basis of 30 cents a ton for ore. This means the breaking of the ore, loading in tram-cars, and the delivery of the cars to the main heading, where the cars are picked up by the company and pulled to the tipple at surface. In these cases the company furnishes drills, air and steel, the contractor, usually a negro, supplies labor and powder. Some companies pay less than 30 cents a ton. The pig iron costs of one of the large mining and iron making companies of the district, with the elimination of all intermediate profits, and by the use of by-product coke, have been under $6.50 a ton, and can now be figured at about $7. Possibly there are others that can not do so well.

In the case of one of the operating companies of the district, the assemblage of materials is on the following basis: It owns a strip of land 4 miles long and about a mile wide. At one end of this strip are its ore mines, as good as can be found on Red Mountain. At the other end are its coal entries. In the center are its furnaces. Connecting all is a standard gauge railway laid with 100-lb. steel, and using cars of 140,000-lb. capacity. This road connects at points less than a mile from the furnaces, with ten trunk lines of railway. Another operating company starts the incline track carrying ore to its furnace mouths in a limestone quarry, suitable for flux. The advantage of this condition is neutralized, however, by the fact that none of these companies use any flux to speak of. Another company has five great blast furnaces in a row, some of them of 500 tons per day capacity. I think it is a fact that nowhere in the world outside of Birmingham can five great blast furnaces be found under single ownership in one, except at Gary.

There are in the state of Maryland four blast furnaces of a daily capacity of about 350 tons of pig iron each. All the iron produced in that state is made in these stacks. Sixty years ago Maryland had no less than 31 active furnaces and their combined capacity was 70,000 tons a year, or as much as the

four now in blast can make in two months. All those old stacks, which averaged about six tons of iron per day, and whose ruins now dot the state, produced iron from brown ore banks that were then active, and all of which lay within a few miles of the stacks. In those days there were many stacks in the city of Baltimore and the ore to run them was mined within thirty miles of the city. Now those ore banks are deserted, and the four great furnaces of Baltimore receive their ore supplies from foreign mines situated more than 1,000 miles away on the Caribbean sea. The Lake Superior district is largely responsible for this and other similar changes in the iron trade.

In New York state there are large deposits of low grade magnetites running, say 40 per cent and better in iron, and up to 2 per cent and more in phosphorous, that are being made into a very high grade ore, both bessemer and non-bessemer, by the elimination of the gangue and of the contained apatite, which is the mineral carrying the phosphorus. They have produced so far, of magnetic ore from this Appalachian field, more than 35,000,000 tons, showing it to be a most important district. At Mineville they are now concentrating these 2 per cent phosphorus ores at the rate of a million tons a year, which is the capacity of their mines, and of their mills when working one shift per day. In these mills they are bringing their 40 per cent ore up to 63 and 65 per cent, and their 2 per cent of phosphorus they are reducing, for some grade, to .03 per cent, and they are making products that do not vary from month to month more than four or five one-thousandth of one per cent in their phosphorus content. Such close work seems almost uncanny. When one considers the vast tonnage probabilities in low grade magnetites on Lake Superior, now unused, he appreciates the opportunities for the application of such methods to the reserves of this region. At Mineville they are able to mine and concentrate on a commercial basis ores running a little better than 50 per cent that are taken out of a 12 ft. seam from 700 ft. underground.

RE-LINING NO. 2 HAMILTON SHAFT WITH REINFORCED DIVIDERS, END PLATES AND POURED CONCRETE WALLS.

BY S. W. TARR, DULUTH, MINN.*

The No. 2 Hamilton (vertical) Shaft, Chapin Mine, at Iron Mountain, Mich., was sunk in 1891, as described in Volume XI, of the Proceedings of the Lake Superior Mining Institute, under title of "The Unwatering of the Hamilton and Ludington Mines" (page 139-147), by John T. Jones.

The original shaft consisted of six compartments, two for skips or bailers, 4 ft. 8 in.x7 ft. 0 in., two for cages, 4 ft. 8 in.x4 ft. 6 in., and two compartments for steam and column pipes for pumping, located in the end of the cage compartments, 4 ft. 8 in.x 2 ft. 0 in., as shown in Plate 1.

This shaft was lined with wood sets, consisting of 16 in.

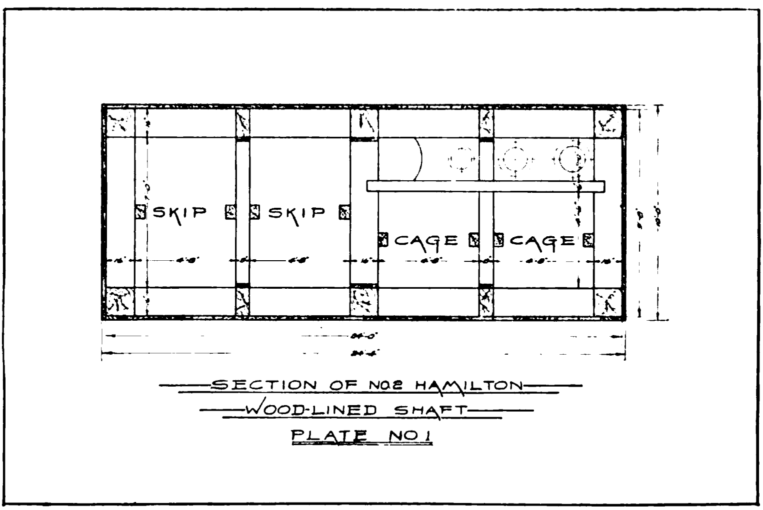


Plate 1. Original Shaft Before Enlarging and Relining

*Engineer of Construction, Oliver Iron Mining Company.

square timbers, spaced 6 ft. 2½ in. center to center, with wood stuttles and steel hanging bolts, the outside of which was lathed with 2 in plank, making a minimum opening to be cut in the rock of 10 ft. 0 in.x24 ft. 4 in. The timbers in this shaft, due to long service, became badly decayed, so that it was necessary to re-line the shaft or abandon it.

Early in the year 1911, it was decided to make the No.

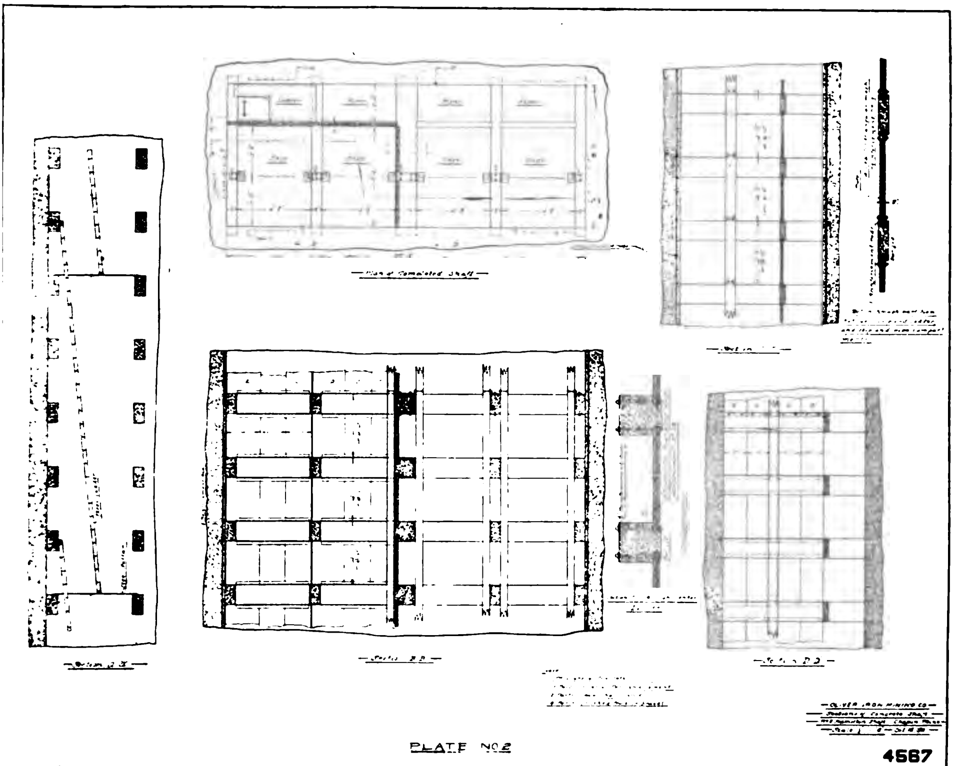


Plate 2. Sketch Showing Enlarged Shaft

2 Hamilton Shaft a permanent outlet to the Chapin Mine, and install in this shaft the permanent underground electrical centrifugal pumping equipment. It was, therefore, necessary to re-line this shaft from collar to bottom, a distance of 1,434 feet, and since there was a possibility of striking another vug of water in the underground workings at any time, provision

had to be made in the design of re-lining so that bailers could be put in service on a very short notice. Since this shaft was to be the permanent outlet, provision had to be made for column pipes and transmission cables to transmit electric power to the underground pumps. To provide for these column pipes and transmission cables, it was necessary to increase the inside dimensions of the shaft from 7 ft. 0 in.x 21 ft. 4 in. to 9 ft. 0 in.x21 ft. 4 in., making the poured concrete wall 6 in. thick. Thus, the outside dimensions of the shaft were not increased over the original wood lined shaft. The shaft now consists of eight compartments, two for skips or bailers and two for cages, each 4 ft. 8 in.x6 ft. 4 in., three compartments for pipes and transmission cable and one for ladder, each 2 ft. 4 in.x4 ft. 8 in., with concrete slab partitions between cage and skip compartments, pipe and skip compartments, and ladder and skip compartments, as per Plate 2.

Various methods of re-lining this shaft were considered, as follows:

1st. Re-lining with timber sets and wood lath, i. e. replacing the present sets.

2d. Re-lining with steel sets and wood lath.

3d. Re-lining with steel sets and reinforced concrete lath.

4th. Re-lining with steel sets, angle stuttles, and concrete poured walls.

5th. Re-lining with reinforced concrete dividers, end plates (made on surface), and poured concrete side walls.

The first and second schemes were neither fire-proof nor permanent; the third and fourth schemes were not considered practicable; the fifth scheme was adopted on account of its permanent qualities, being strictly fire-proof and water-proof.

Concrete Mixing Plant.

To economically make the reinforced concrete dividers, end plates and slabs, also the concrete for poured walls in shaft, a concrete mixing plant was built near the shaft, as shown on Plate 3. The mixing plant consists of a crusher, bucket elevator, revolving screen, two concrete mixers, pocket

divided into three divisions for sand, gravel and "over-size," and a drying room, equipped with an overhead hand traveling crane.

The material for these dividers, end plates and slabs is

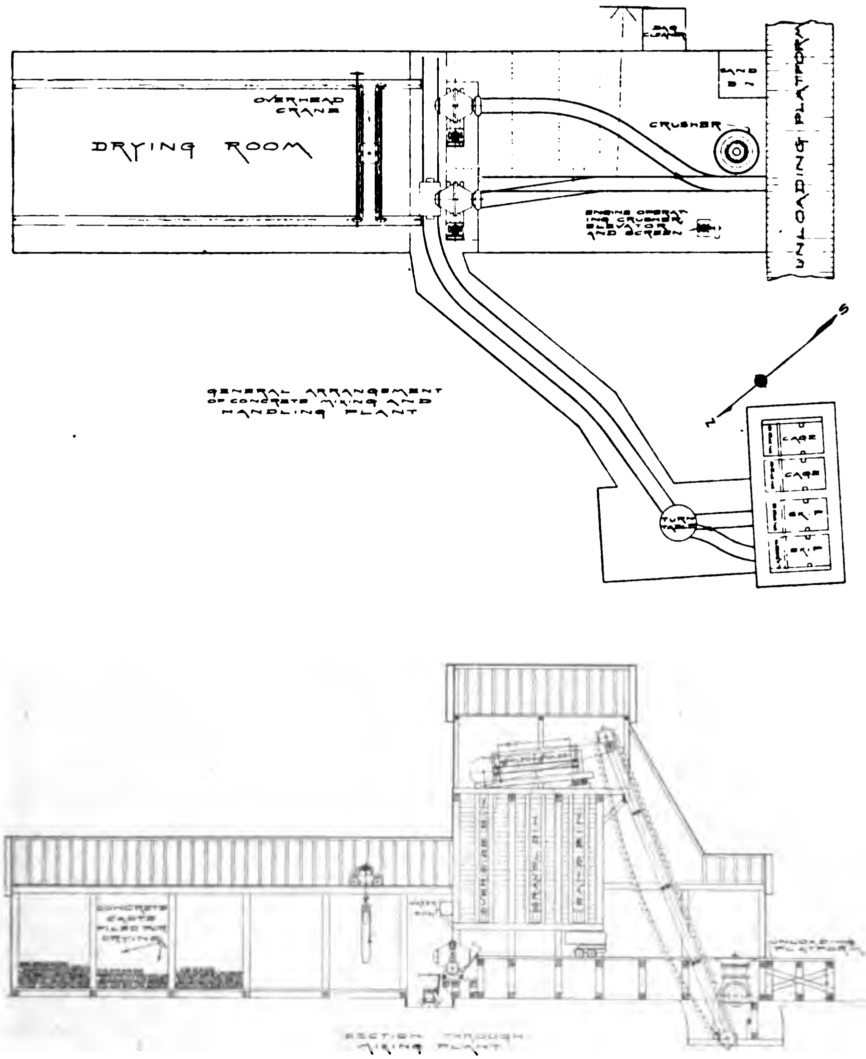


PLATE NO 3
Plate 3. Concrete Mixing Plant

brought to the mixing plant from a nearby gravel pit in dump wagons. This gravel contains a large percentage of sand. The material from the wagons is dumped directly into the crusher. The product from the crusher is discharged on to the bucket elevator which elevates it to the cylindrical revolving screen. This screen is divided into two sections. The first section is perforated with ⅜ in. diameter holes and the

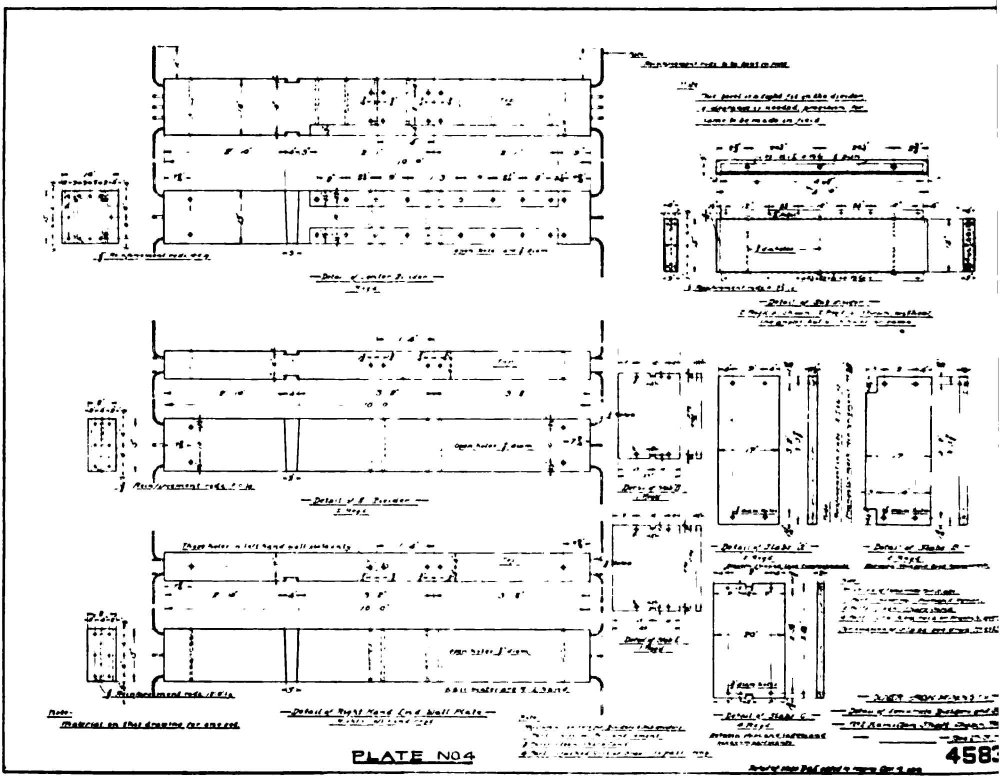


Plate 4. Detail of Concrete Dividers and Slabs

second section with 1⅛ in. diameter holes. All aggregate passing through the ⅜ in. diameter holes is termed as "sand" and all aggregate passing through the 1⅛ in. diameter holes is termed as "gravel." The material larger than this is termed "over-size." This "over-size" is used either for backfilling the concrete walls in the shaft or may be drawn out from the

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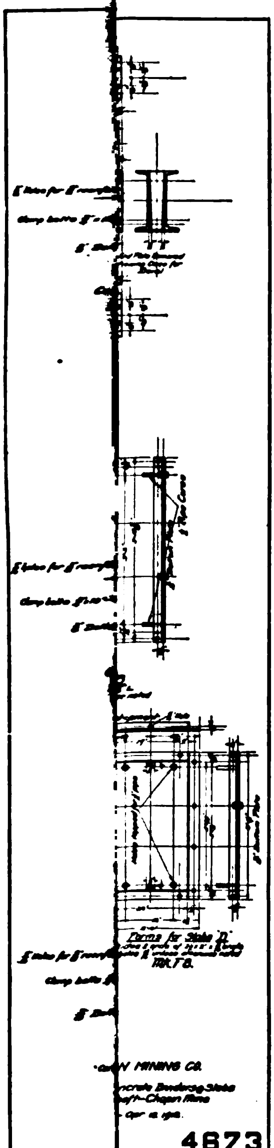

Forms for Slabs "D"
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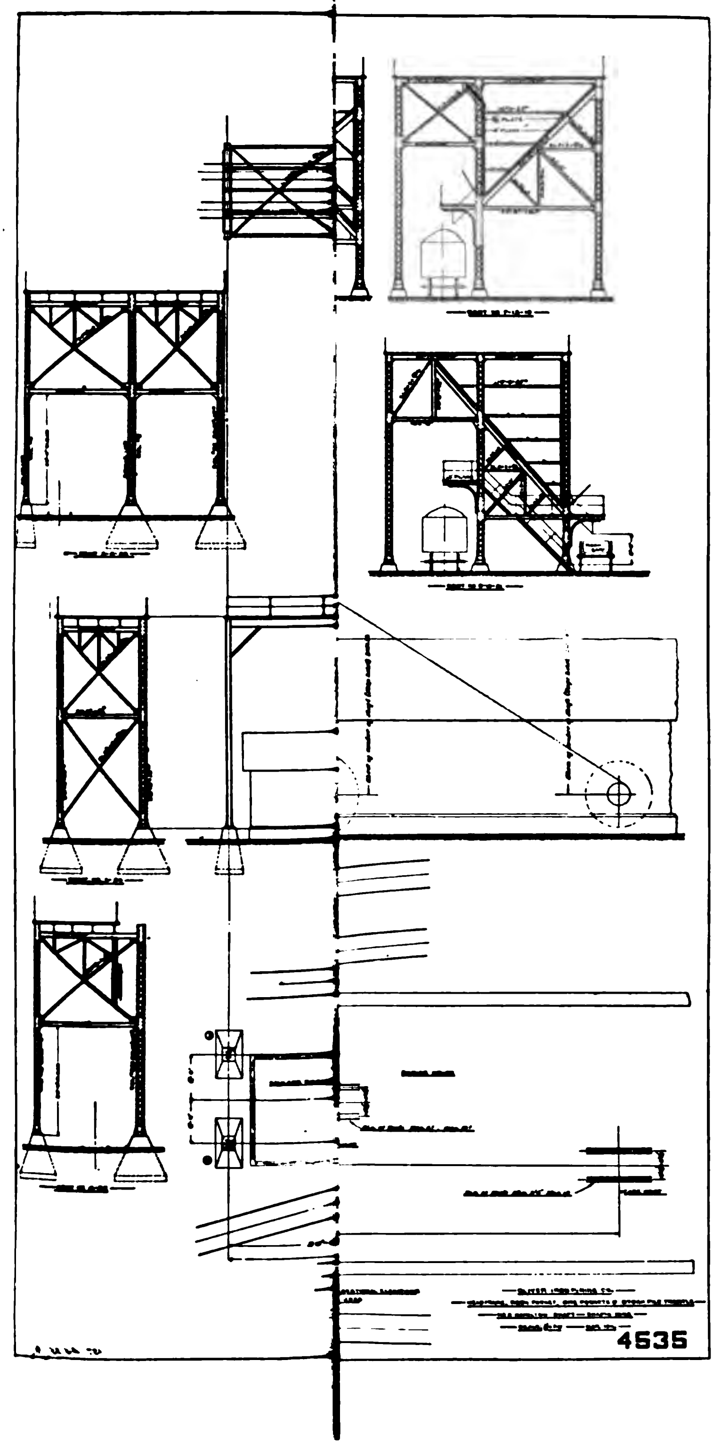

pocket into a tram car and returned to the crusher for re-crushing. The concrete mixers used are Smith No. 1, of nine cubic feet capacity. The ingredients are brought to the mixer in tram cars. The body of the tram car is divided into three sections to hold the required amount of sand, gravel and

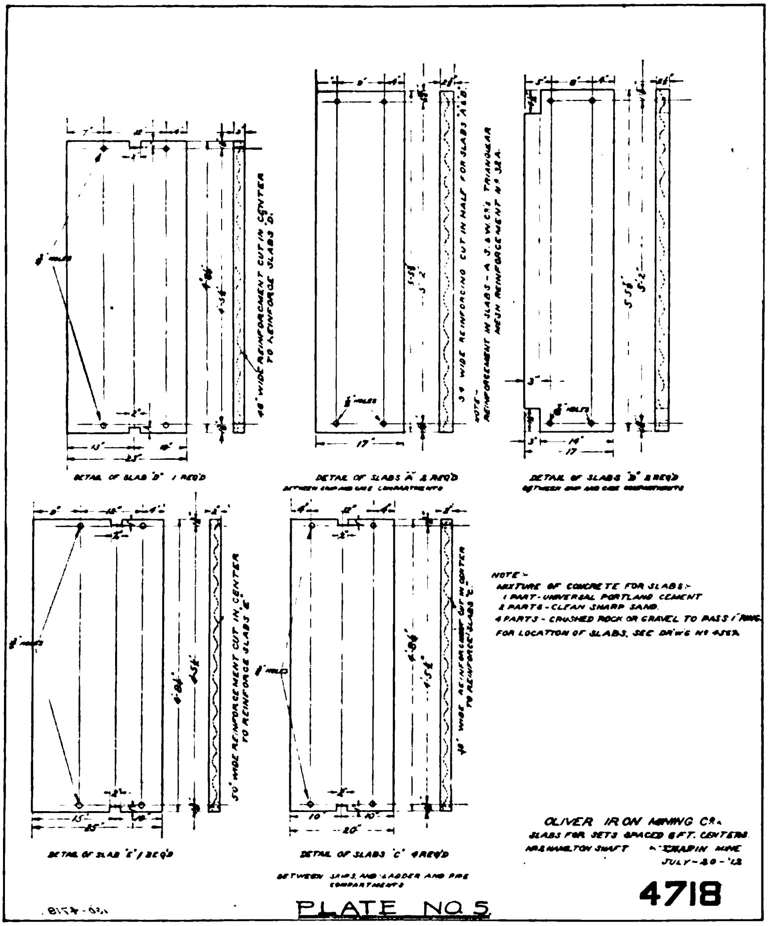

Plate 5. Detail of Concrete Slabs

cement, to give the proper mixture of one portion of cement, two portions of sand, and four of gravel, for the making of reinforced concrete dividers, end plates and slabs, and shaft wall. By moving under the sand and gravel spouts, the car

is loaded with the proper portions of sand and gravel, and the required amount of cement is poured into the car from sacks. The loaded car is trammed to the mixer and contents dumped in same. A water measuring box is placed above

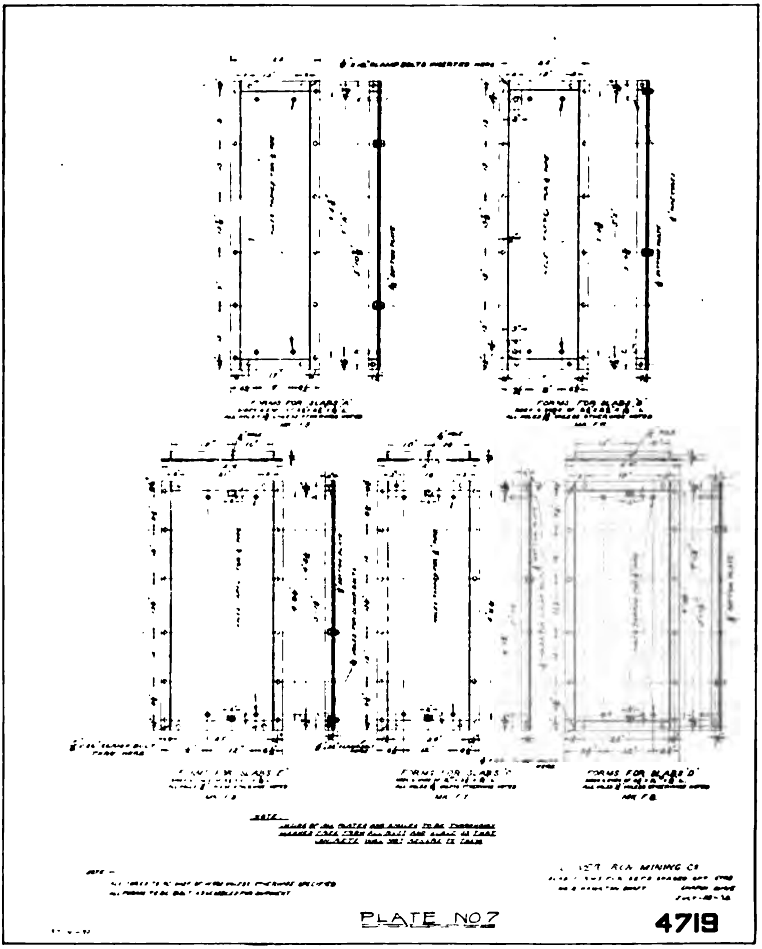

Plate 7. Steel Forms for Making Concrete Slabs

each mixer, which discharges the proper amount of water into the batch to be mixed. The dividers, end plates and slabs are made in steel forms. These forms are placed beneath the mixer from which the concrete is poured directly into them. After

the concrete has been in the forms a sufficient length of time to harden, the forms are removed and the moulds are picked up by the hand traveling crane and carried into the drying room, where they are cured. The design of reinforced concrete dividers, end plates and reinforced concrete slabs are shown in Plates 4 and 5. The steel forms for making the same are shown in Plates 6 and 7.

METHOD OF RE-LINING SHAFT WITH POURED CONCETE.

The work of re-lining this shaft is done in sections. Each section is started on permanent bearers located to support the present timber shaft sets, and working upwards. A section of old timber, usually 12 ft., is removed and loaded on to the cages and hoisted to the surface, where it is unloaded on to cars and dumped into the cave nearby. The timber sets above these portions are supported by means of vertical columns with jack screws on the bottom, resting on 12x12 in. timber placed on the bearers. After the first 6-ft. section of concrete is poured, the 12x12 in. timbers are placed on the reinforced concrete dividers and end plates, which are supported on steel forms, as shown in Plate 8. The steel forms are made in sections, with recesses to support end plates and dividers spaced either 4 ft. or 6 ft. centers as shown in Plate 9. Since there are seven sets of steel forms, the footings to carry the weight of old timber sets will bear either on the permanent bearers or on at least five sets or 30 ft. of concrete, i. e., the support of the old timbers above does not depend upon green concrete. After the sections of steel forms, 6 ft. high, are lowered in the cages and installed, the reinforced concrete dividers and end plates are lowered and placed in the recesses provided in the steel forms, and the ends bolted to the steel forms. These end plates and dividers serve as horizontal struts to hold the steel forms in position. When a section is placed, the vertical reinforcing rods are put in position in the wall, and the wall is now ready to be poured. The concrete for this shaft wall is mixed on the surface at the mixing plant and discharged into side dump steel cars, which are pushed by

hand from the mixer to the shaft. A turn table is installed about 15 ft. from the shaft, tracks from which lead to both skip compartments. Cages are used in both of these compartments. The concrete car is run on to either of these cages from the turn table and lowered into the

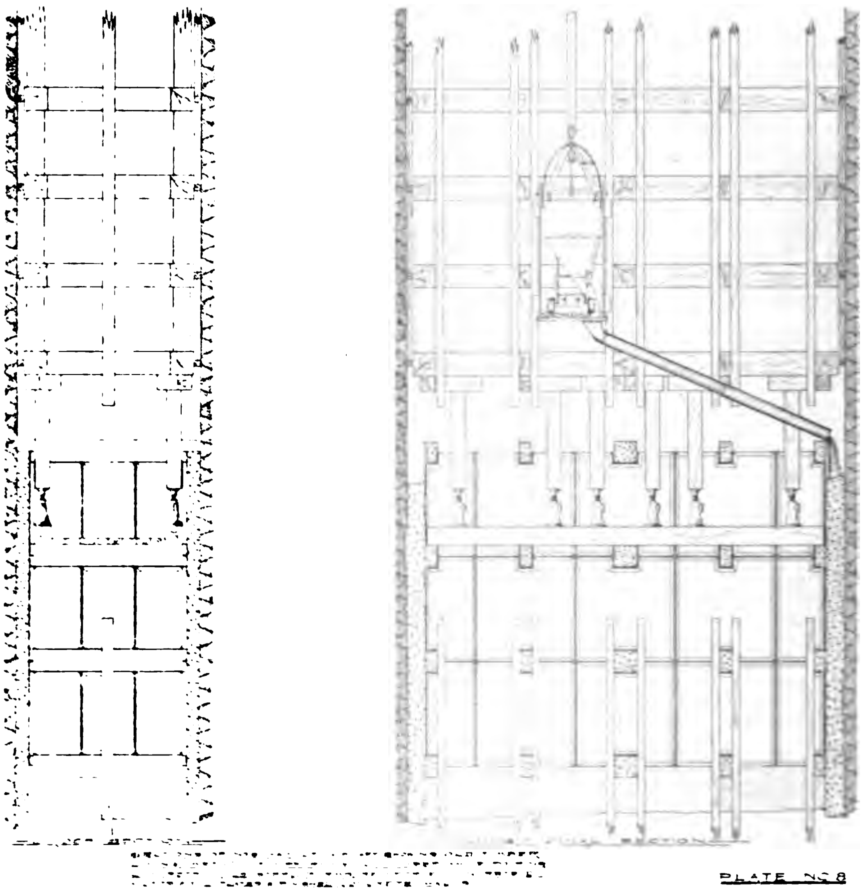

Plate 8. Showing Method of Pouring Concrete

shaft. A revolving chute is attached to the spout of the car and the contents are discharged behind the forms to make the wall and properly tamped in place as shown in Plate 8. In places there are large crevices in the shaft. Where these

crevices occur, they are filled to within 10 in. of the steel forms with large stones or rock from the over-size bin before the concrete is poured. The average amount of material for relining one 6-ft. vertical section of shaft is one cord of stone for backfilling 10 cu. yards of concrete, and 550 pounds of steel for reinforcing.

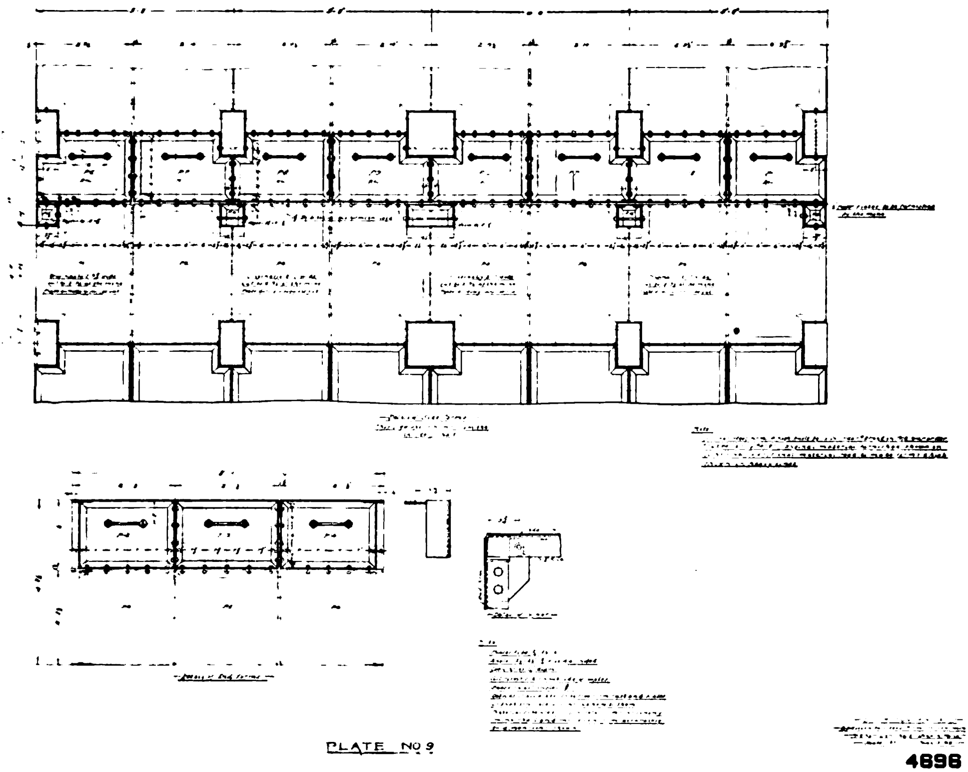

Plate 9. Steel Forms Made in Sections, With Recesses to Support End Plates and Dividers

Number of Men Employed.

In removing old timber, five men are required to work below and one man at the collar to handle old timbers from the cage and dispose of same. The time required to remove one 6-ft. section varies according to the condition of the old material in the shaft. In placing steel forms, four men are required below and two at the collar to lower the forms on

the cage. In pouring concrete, four men are required below and two men at the collar. The above number of men does not include the shaft foreman, concrete foreman, hoisting engineer, or men working in the mixing plant, as these men do not spend all their time on this particular job. The re-lining work is carried on in three eight-hour shifts per day, and the average time required to concrete 6 ft. of vertical shaft is 24 hours, or three shifts, which includes placing the forms, pouring concrete and removing an equal amount of forms. When the forms are removed, they are taken to the surface, thoroughly cleaned and given a coat of crude oil before they are used again.

All hoisting and lowering of material is done with the present reel hoists located in the No. 2 Hamilton engine house, as shown on Plate 10.

When it was decided to make this shaft a permanent outlet, a new steel headframe, stockpile trestle and idler stand were erected, as shown on Plate 10.

On account of the heavy flow of water in the underground workings at this shaft, it was necessary, in dismantling the old wooden head-frame and erecting the new steel head-frame, that this work be done in the smallest possible time, as bailers might have to be put in operation on very short notice. When it came time to make this change, the old wooden head-frame was dismantled and the new steel one erected ready for hoisting in ten days. In the design of re-lining, the provision made for installing bailers on 24 hours' notice proved to be a good precaution, as a vug of water was encountered on October 22d, 1912, and the bailers were put in operation within 24 hours, thus preventing the flooding of the lower workings of the mine.

Progress of Work.

The first portion of the work of re-lining this shaft was started 83 ft. 3 in below collar of shaft, on May 3d, 1912, and the concrete lining between this point and the collar was completed on June 29th, 1912. The second portion was start-

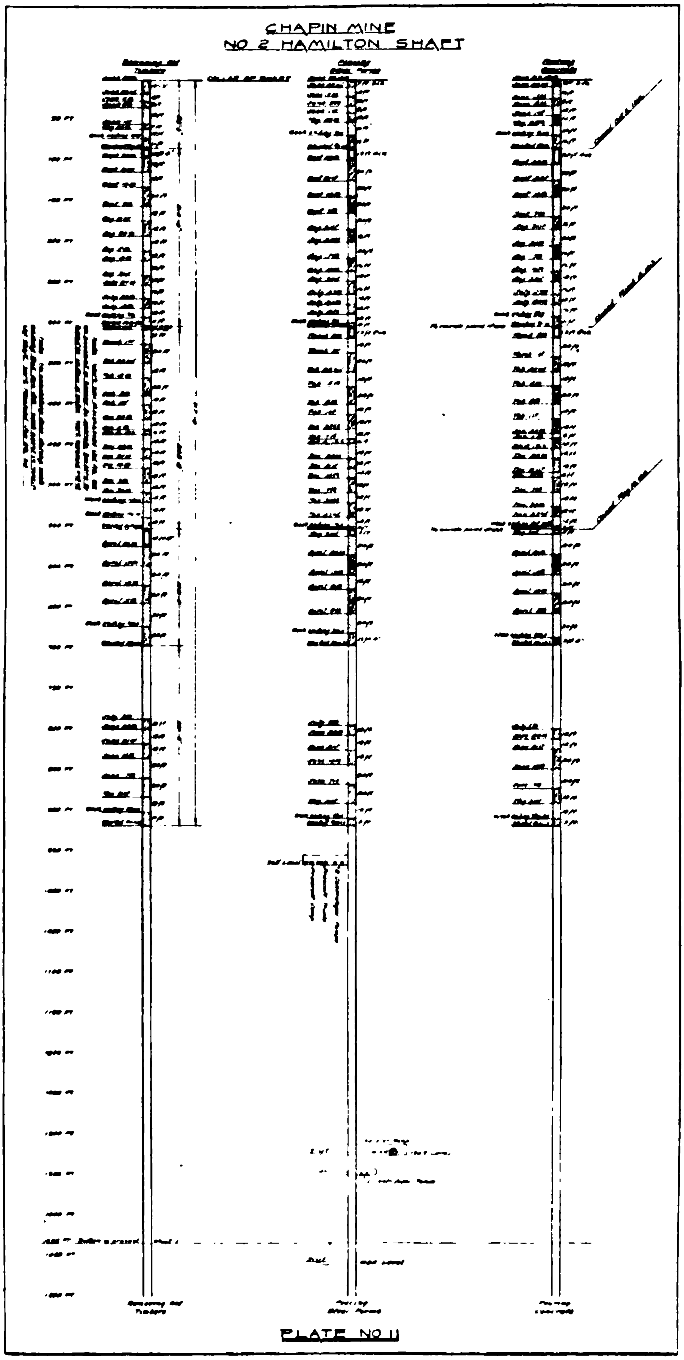

Plate 11. Showing Progress of Work

ed 302 ft. 7 in. below collar of shaft, on July 1st, 1912, and was connected to the first portion on October 5th, 1912. The third portion was started 551 ft. 3 in. below collar of shaft, on October 12th, 1912, and connected to the second portion March 15th, 1913. In this portion, the shaft work was discontinued from October 22d to November 18th, 1912, on account of striking the vug of water on the 16th level. One week was also lost between January 11th and January 18th, 1913, on account of a slip of old timbers in the shaft. The fourth portion was started 695 ft. 7 in. below collar of shaft, on March 22nd, 1913, and was connected to the third portion on May 10, 1913. The fifth portion was started 917 ft. 4 in. below collar of shaft on May 17th, 1913, and to July 5th, 1913, 812 ft. 7 in. of the entire shaft have been completed. Weekly reports of the progress of this work are sent to the Chief Engineer's office, where a graphic report is kept, as shown on Plate 11.

The average rate of progress since the beginning, without deducting the time due to delays, is 56.7 ft per month, or 63 ft. per month for actual working time. The progress for the past month was 72 feet. The preliminary estimate was based on re-lining 100 ft. per month. The old shaft timbers however, were in far worse condition than could possibly be anticipated, and the slower progress has been due entirely to the difficulty in removing the old timbers and the precautions required to protect the lives of the men who are employed on this work

In the portion of shaft completed to date, all the work has proven perfectly satisfactory and entirely up to expectations. The walls are smooth and waterproof. The reinforced concrete dividers and end plates come from the steel forms perfectly true, straight and smooth, and fit perfectly in the recesses provided in the steel forms.

All cement used in the construction of this shaft lining was furnished by the Universal Portland Cement Company, and the steel forms, reinforcing rods, steel head-frame, stockpile trestle and idler stand were furnished by the American Bridge Company.

SUGGESTIONS ON THE APPLICATION OF EFFICIENCY METHODS TO MINING.

BY C. M. LEONARD, GWINN, MICHIGAN.

The original application of the term "Efficiency" was made to machinery and was represented by the work accomplished, divided by the energy expended. This result in the older type of machines was very low and men specially trained, made a study of the application of power and the results and by some small change in the organization of an engine, the use of a different type of valve, the use of the condenser, etc., have increased this factor several hundred per cent.

In 1883. Fred W. Taylor realized that the efficiency of human energy was low, began to analyze operating conditions and the result of this analysis is one of the prime factors which enables American industrial labor to earn more per day than in any other country and American manufacturers to sell their products at a profit in countries where labor receives but 40 to 50 per cent of what it receives in this country.

Until a comparatively recent date, efficiency engineering was confined to industrial plants and construction work. The results obtained in these lines has suggested its application to mining and from the very nature of the necessary working conditions in mining, it would seem that even greater results might be looked for than in other industries.

The cost of production in mining may be divided into two parts, viz: Supplies and Labor. Of these the latter is the larger.

Supplies—

Supplies are usually considered practically a constant factor

in the cost of production. They are, at least, less affected by a study of the details than labor.

The importance of having excessive capital tied up in supplies is recognized, but it is doubtful if the interest on the amount necessary to carry an adequate stock of those in general use, would meet the loss due to the delays caused by continually running short of material. The amount of supplies which is necessary to carry, is affected by the standardization of equipment. For instance, nearly every manufacturer of power drills is glad to have his machine given a trial. If this trial were made on ground which were fairly uniform, a careful record kept of the performance of each machine and a comparison made of the records, it would probably result in one machine of each type being selected as a standard and a basis established for the purchase of power drills. The adoption of one brand of steel usually insures more uniform results in the forge and consequently a better bit sent underground.

Fuel, one of the principal items of supplies, is now purchased by most operators on an analysis basis, after determining the fuel best suited for each condition.

One company has reduced the cost of their lubricating oil by using a commercial grade of a thick oil, adding other lubricants to meet various conditions.

A study of explosives, their application and instructions in their use may result in a saving of a cent or two per pound in this item or a pound or two of explosive per foot of drift.

The use of carbide lamps underground has demonstrated that they not only cost less but give a better light and are smokeless.

Labor—

During the past ten years, it has been necessary for the mining industry to meet an increase of wages, varying from 8 to 21 per cent, a decrease of 20 per cent in the working hours and in many instances, a decrease in the price received for their product. The one object of labor is to receive larger

wages and one of the main objects of the operator is to get lower costs. The question naturally presents itself, how can this condition be met to the satisfaction of both parties? There can be but one answer to this and that is by increasing the efficiency of labor.

The conditions which have a direct bearing on the efficiency of labor are so varied, that an exhaustive treatment can not be brought within the confines of one paper. Not only each district but each mine presents a different proposition in itself and a study of the details of the operating conditions is the only manner by which we may arrive at any definite solution. From our practical knowledge we may be able to sense a thing as being right or wrong. This judgment may err 5, 10 or 15 per cent one way or the other and may represent the margin between a profit and loss, but from a set of figures compiled from a time study of the complete cycle of operations, from breaking the ore until it is loaded on surface, one is able to determine to what extent and at which point it is possible to make changes and the exact result of these changes. It enables the work to be so co-ordinated that each man is given an opportunity of doing a days work and is not being held up by some other operation. It also provides an intelligent basis for making contracts and if the average man does not make the minimum wage, it is his fault rather than an error in judgment on the part of the foreman.

A time study to be of practical value, must be enough in detail and cover a sufficient period of time to enable one to get a fair average of the time required on each operation, and one which does not give this information is worse than useless as it permits false conclusions to be drawn. To get positive results from this work it is absolutely essential that the co-operation of the entire executive force be maintained and if there is any inclination on the part of a boss or foreman not to co-operate in ~~the work~~, there remains but one of two courses to pursue, either discontinue the work along these lines or dispense with that persons services.

No trouble should be experienced in getting the men interested in the work for as soon as they realize that it means an increase in their wages, they are only too glad to make an extra effort. The men should be dealt with individually as far as possible. The force of this is apparent when a man is taken from day labor and given contract work. He immediately realizes that a premium is being offered for better work and can see some tangible reason for making a greater effort. It is generally recognized that any system of efficiency that does not provide for a division of the benefits to be derived from any changes which affects labor, will prove a failure, and while a large percentage of the men working underground may not be able to speak English fluently, there are few who, at the end of the month, do not know approximately what they have made and a settlement on any other basis will not prove conducive to the best results.

There are conditions in which it is rather difficult to figure a contract basis. For example, in the Lake Superior Copper District, the cost of copper per pound depends upon the quality of rock hoisted as well as the quantity. This necessitates underground sorting, which item is a large proportion of the underground expense. When this operation is placed on a contract basis, the quality of the rock decreases and the quantity increases as well as the cost of copper per pound.

To a certain extent, efficiency work is a matter of education. While a practical training is absolutely necessary to one who in any way has charge of men or is planning work, it is of prime importance that they be able to appreciate the value of figures. The result of a time study placed before some of the older mining captains would produce about the same feeling toward them as the man lost in the woods has toward his compass. He will agree that they ought to be right, "but that they are certainly off this time."

In the majority of cases the men themselves may be taught to accomplish the same or greater results with an expenditure of less physical force. This can not be done by

simply explaining the method but must be demonstrated. It may be necessary to take four or five cuts out of a drift before you can convince a gang that they are not placing their holes to the best advantage. This part of the system of education is usually left to the boss, whose territory is so great that he cannot give sufficient time to any individual gang or operation, to get the best results and too often his attitude toward the men may be that if they do not get the best results, they are on a contract and they, not he, will be the losers.

There are many other conditions which have a direct bearing on the efficiency of labor, some of which are of such nature that the results can not be measured in dollars and cents. For instance, one large copper mine in the Southwest employs an expert to provide ventilation form stopes where the air is too hot or impure. Sociological and welfare work, which might be considered a dead expense, undoubtedly has a direct bearing on the efficiency of labor, in tending to preserve the health, loyalty and continuity of an organization. If it were possible to determine to what extent the cost per ton of ore or per pound of copper were affected by this expenditure, it would doubtless show a balance on the credit side.

MINE LAWS, SPECIAL RULES AND THE PREVENTION OF ACCIDENTS.

BY E. B. WILSON, SCRANTON, PA.*

To cover exhaustively the subjects of this paper would require that a large book be written, even then it is improbable that the continually changing conditions about metal mines could be anticipated so as to present all the various matters which culminate in accidents; the unforseen possibilities that may arise for changes and additions to mine laws; or the necessity for formulating new rules. The very uncertainty of things makes this paper of a general nature, nevertheless, there are specific matters that come under these captions to which attention is directed.

That there may be no misunderstanding, this paper is not a criticism, but one in which are stated conditions as they are recorded. In the writer's opinion therefore no individual operator can assume complacency in this matter, but rather all should unite to remedy the conditions collectively.

In most mining states laws have been passed to compel mine operators to do certain things and post certain rules, and, to see that the provisions in these laws are carried out, state mine inspectors are appointed or elected, whose power also consists in recommending safety measures, and pointing out dangers. In some coal mining states the inspectors are able to close mines and bring suits if operators do not comply with their suggestions.

In going over the various state mine laws in operation and proposed, one will find a list of subjects adopted years ago, but now suited only for use in kindergarten mining. There are

*Editor, The Colliery Engineer.

also "Dont's" for operators and everyone else about a mine which to say the least are insults to average mining intelligence, but there are also some features in these various state laws which are good and might be adopted more extensively to advantage. Copies of these laws may be obtained by writing to the Secretaries of the various metal mining states, and a proposed uniform metal mining law may be obtained by writing to James F. Callbreath, Secretary, American Mining Congress, Washington, D. C.

Inspectors have had laws enacted which proved burdensome without corresponding decrease in fatalities, they have also created considerable friction by their suggestions and demands for their enforcement, but, as a rule, when they receive their office by appointment, and not by election, they work as harmoniously with the operators as the nature of their oath will permit.

The selection of a state mine inspector is a matter of considerable importance as his first duty consists in providing for the maximum protection to mine workers. Violations of mine laws by operators, mine officials or mine workers, whereby the lives and health of men are jeopardized, must be prosecuted, therefore a mine inspector must be conversant with conditions existing in mines, and besides having an extensive practical experience must possess moral courage and a mental temperament that will ensure the avoidance of hasty and ill-advised action.

If inspection is to be properly performed, competent inspectors must be obtained free from any influence that will detract from the powers vested in them. The proper way in the writer's estimation to obtain competent inspection is by appointment by the Governor, he however to be limited in his appointments to men who have passed a civil service examination before an examining board composed of three mining engineers, three mine bosses and three miners. The examining board may select from the candidates who have passed both a written and oral examination with a percentage

of 90, those who have temperaments and moral characters that may be depended on and recommend them for appointments.

In the anthracite fields of Pennsylvania men have been elected inspectors not because of character or ability but because they were politicians. Most of those who vote for mine inspectors, being farmers, laborers, business and professional men, are incompetent to judge as to the fitness of candidates for mine inspectors, in fact may never have seen or heard of them before their names were placed on the ballot.

This is not all, if an elected inspector wants to retain his office he must be "suave"; a "trimmer" at all times; spend most of his time electioneering for himself and party and not offend any of his constituents or they will defeat him at the polls.

A good inspector should be kept in office so long as he is physically able to perform his duties, and if a poor inspector is appointed his removal should be recommended by the examining board that had him appointed. The constant change in inspectors made possible by the elective law, or by executive appointments, if not surrounded by civil service limitations, frequently makes the laws farcial to an extent which gets on the public nerves. After following both the appointment and the election plans of creating inspectors, I am convinced that the plan here proposed will prove more satisfactory to miners, operators and the public than any other that has been advanced.

Large coal companies not satisfied with periodic state mine inspection, hire company inspectors who examine the mine and appliances and suggest both changes and improvements that make for safety. Provided the right kind of a man is employed, a company inspector will save his wages readily by acting as an efficiency engineer. In positions of this kind only experienced men with liberal educations should be employed, and if a concern is not large enough to hire such a man two or three should club together for the purpose. That he may not conflict with the Superintendent and Foreman a perfect

understanding as to each one's duties should be stated in writing. Further he is not to give orders either above or below ground and should write his suggestions in triplicate for the benefit of the Manager, Superintendent and Foreman.

In the absence of state mine laws to govern metal mining, it certainly is advisable that the operator appoint a safety committee, make a uniform set of mine rules, make use of danger signs, and also issue from time to time Safety Pamph-

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Fig. 1

lets for the miners all over the fields, calling attention to the accidents that have happened and how they may be avoided.

Where there are state mine laws both the miner and the operator must observe them, and in addition the miner must abide by the rules of the company. It is undoubtedly true that the number of accidents may be decreased by united efforts to teach the miners to care for themselves and by using strict disciplinary measures to regulate carelessness and evasion of rules. It is not enough to make one set of rules for the guidance of the miner, special sets of rules must be formulated for those men who follow distinctive lines of work inside and outside the mine.

In case of an accident the cause should be investigated and wherever possible a rule formulated in such a way that a similar accident will not be likely to occur. Although this may produce radical changes in the work and the discharge of several men for infringement of the rules, nevertheless it has been

found to add to efficiency and eventually decrease accidents.

The most difficult cases to contend with will be those of old miners who have worked for years doing things certain ways. They are "bull-headed" and will tell how long they have mined, etc. However, they must understand that they are to do things differently if they want to continue at work. These men may purposely do things they are told in a wrong way, but a lay-off with the reprimand that they are not good miners will bring them to reason.

In mining two parties are concerned in an undertaking in which a contract is implied if not signed, sealed, acknowledged, and recorded. Both miner and operator are under obligations by this contract to refrain from doing or leaving undone those acts which will work injury to the other. This being a recognized fact the next step is for the contracting parties to work in harmony for mutual benefit, in other words, place confidence in each other.

Mr. Thomas Lynch, head of the H. C. Frick Coke Company seems to have gained the confidence of his men, by appointing a safety committee of miners who investigate whenever a miner anticipates danger and who immediately recommend that conditions be made safe. A comparison between the fatal accidents in Great Britain and the H. C. Frick Company per million tons of coal mined is 4.52 to 1.88. The H. C. Frick Coke Company produced in 1912, twice as much coal per fatal accident as the bituminous fields of Pennsylvania, Ohio, Illinois, and West Virginia. The success of Mr. Lynch in decreasing accidents is due to his making the men responsible for them, and by the strict enforcement of mine rules.

Michigan employed 31,584 metal miners in 1911, of which number 134 were killed or 4.24 per thousand employed.

Minnesota employed 16,548 metal miners of which number 76 were killed or 4.59 out of every 1,000.

As Michigan and Minnesota employ 29 per cent of the 165,979 metal miners in the United States it naturally follows that there would be more accidents in these two states,

but we find on further analysis of the Census Bureau Reports that Houghton County, Michigan, had 563 deaths recorded during the period extending from 1894 to 1908, inclusive, yet in every one of these 14 years the death rate was less per thousand men employed than in the iron mines of the state. The average by counties was as follows: Dickinson County, 4.01; Houghton County, 2.94, and Marquette County, 4.32.

The writer has no statistics relative to the Minnesota Mine accidents for the 14 years mentioned, however, the data compiled by Albert H. Fay and printed in the Bureau of Mines Technical Paper 40 is sufficient to show that the fatal accident list is much too high being 4.59 per 1,000.

Taking Mr. Fay's figures, the total number of fatal accidents in 1911 in Michigan and Minnesota ore mines were 157, while those seriously injured numbered 1,839. These are tabulated for ready reference as follows:

ACCIDENT TABLE LAKE SUPERIOR ORE MINES 1911.

Cause.	Killed.	Per cent of total.	Seriously injured.	Per cent of total.
Falls of rock or ore......	65	41	611	33
Timber or hand tools......	3	2	192	10
Explosives	13	8	45	2
Haulage	4	3	392	21
Falling down chute, or winze, raise or stope...	10	6	92	5
Falling down shafts	27	17	18	1
Run of ore from chute or pocket	6	4	70	3
Drilling machines			132	7
Electricity	1	0.6	2	0.1
Machinery other than drills and locomotives	5	3	60	3
Mine fires	8	5		
Natural gas	1	0.6		
Miscellaneous	10	6	199	11
Objects falling down shafts	3	2	21	1
Hoisting rope breaking....	1	0.6	1	0.1
Overwinding			4	0.2
	157		1,839	

It is customary for statisticians to tabulate accidents which occur on the surface separately from those which occur under-

ground and also to sub-divide the accidents under headings. In the accident table, only underground and shaft accidents are given.

In 1911 there were 32,793,130 tons of iron ore and 10,978,827 tons of copper rock mined in the Lake Superior region, but for every 278,802 tons of ore raised one life was lost, and for every 23,802 tons a man was seriously injured.

Accidents above ground seem to be due to carelessness, although frequently it is commendable if misguided carelessness when to save property or time the employe risks safety. It

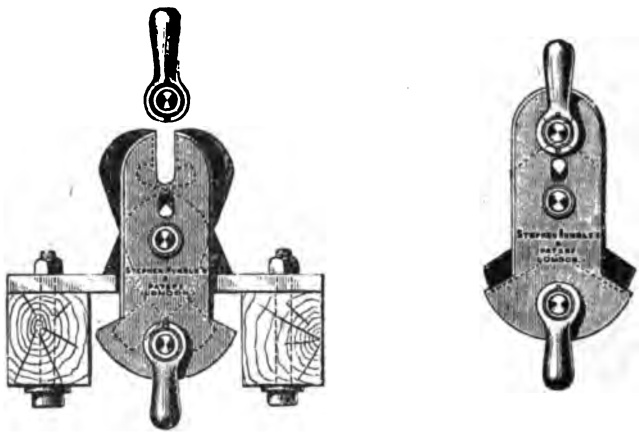


Fig. 2. Safety Hooks

should be thoroughly instilled into men's heads that no piece of property is worth so much as his life. Outside accidents happen through machinery; haulage arrangements, tramming, coupling and dumping cars; falls from headframe and staging; while carrying tools or materials; into chute or ore bin and getting caught with running ore; and in getting on or off the cage or bucket at the surface. Overwinding is not so common as it once was, since at a large number of small operations Humble or Akron safety or detaching hooks have been adopted and at large mines overwinding devices are used that take control of the hoisting engine if the engineer is incapacitated or fails to pay attention to the work or the indicator fails to register correctly.

That the top of all shafts, slopes and machinery is to be fenced goes without saying, and so far as my observation goes this is done at the Lake Superior mines without laws. Shaft gates should be arranged to open automatically whenever the landing is at the surface. Where, however, the landing or dump is above the ground, the surface gates should be kept locked. There is danger from pieces of ore falling from the dump where self-dumping cages and buckets are in use, and people should be warned from standing near the shaft collar when dumping is carried on above ground. Skips usually dump so far into the chute that with ordinary care no ore falls outside the chutes.

Getting off or on the bucket, skip or cage when in motion is a frequent cause for injury. No one should be allowed to

Fig. 4. Fancy Skip Riding, Two Skips on One Rope

ride on cages carrying supplies except the man in charge and he should be instructed how to fasten the material so it will not move on the cage or project beyond the sides.

At a mine in one of the eastern states, the men ride down the slope on skips. In addition to their overcrowding the skip they ride on the outside and on the rope steadying themselves by placing their feet on the rail. While the speed of hoisting is not fast, there are any number of chances for accidents. The number of men that shall ride in a skip or cage should be posted at the top and bottom of the mine and at

each level. The man that gets on after this limited number is reached should be laid off and for a second offense discharged.

Hoisting ropes should be inspected each morning before the men go down and each evening before the men come up. This is readily done by letting the rope run slowly through the gloved hands of two men. Ropes are subject to greatest wear near the cage fastenings and the clamps or sockets should be examined each morning and evening, also bridle chains should be used. Occasionaly a timber or tool may drop from a cage, etc., or a trammer may push a car from a level into the shaft and follow it down, or as in Colorado men may be killed by being struck with a descending cage or bucket; however, to guard against the numerous kinds of accidents that might happen in a shaft, rules should be posted stating what may not be done. It is considered advisable to give publicity to shaft accidents and show how they may be avoided. This is best accomplished by an operator's Publicity Pamphlet.

One fruitful source for accidents in the Lake Superior metal mines is falling down shafts, 17 per cent of the fatal accidents being due to that cause. It is hard to account for this if the levels, stations and shaft collars are properly fenced and run-arounds provided. It may possibly be due to falling from ladders. It certainly is not due to overwinding or the hoisting ropes breaking, for such accidents are reported separately.

There were three killed by objects falling down shafts and 21 injured. The table fails to specifically state whether the objects were loose rock from the sides of the shaft or material falling from buckets, skips or cages overloaded.

In this connection no one should be permitted to stand directly under a shaft opening, and not close to the shaft on a level. The shaft walls should be examined at regular intervals from top to bottom and loose rock taken down or timbers repaired as delay may prove serious. Universal danger signs should be freely used to warn people of a danger zone.

When shafts are being repaired, the men should be provided with strong platforms braced rigidly to the top members of the cage. A swinging platform below the cage is not safe.

Falling down chutes, winzes, raises and stopes, killed 10 and wounded 92 men. Ladders should be provided in raises and winzes and kept in repair. Chain ladders will be found serviceable in this connection and when provided with stretchers of great help in avoiding accidents. Hoisting men out of winzes by a windlass is not so safe as making use of ladders. In raises care should be taken to see that the timbers supporting the staging have proper footings even if it requires cutting hitches. Chicken ladders well made will answer for stope climbing if properly fastened at the top and bottom. Where winzes connecting levels are used for ventilation and exit, good ladders should be provided, all other openings on levels should be boarded over to prevent falls, and those used as traveling ways should be fenced on the upper level. The number of winzes on each level equipped with ladders will of course be only those used for traveling ways.

When there is a ladder compartment the ladders should not have an inclination above 60 degrees and should have substantial landings at least every 20 ft. The rungs of the ladders should be inspected and repaired quickly when broken, likely to break, or missing. Men carrying more than one tool should not be permitted to climb ladders. At about 25 ft. from the surface a bulkhead should be placed over the ladder compartment; from this bulkhead a level should be driven and in the case of comparatively level surface ground a riser made. There are a number of reasons for this level among which are: prevention of material falling on men's heads; improved ventilation; in case of fire in the head house or near it, the men will not be overcome with gases, and besides forming a partly second opening it gives the men a chance to rest.

While there were but four fatal haulage accidents in the Lake Superior mines there were 392 serious injuries. It would

appear from this that more are injured by haulage arrangements in ore mines in proportion to the number of men employed than in coal mines where haulage is longer and where many more cars are in use. There being no data to go by, the only suggestion to be offered is a warning to men not to ride on loaded cars or jump from moving cars. Rules made

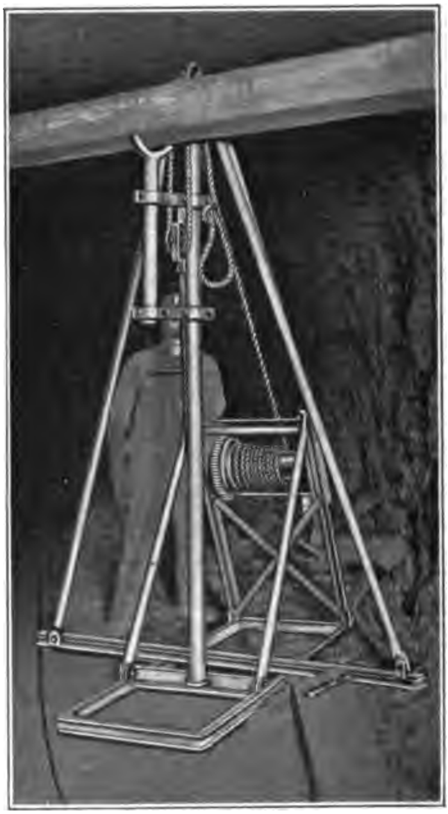


Fig. 5. Collapsible Timber Derrick

to cover haulage matters underground should be strictly enforced.

As in coal mines it is found that rock-falls are the most prolific cause of accidents underground and the most difficult to prevent. The manager can go only so far as to furnish materials that men may protect themselves; however, with the

aid of inspectors men may be educated to protect themselves. In this connection inspection will disclose whether the sides of the level are in order, and another frequent source of injury will be removed namely falls of rock when traveling through levels.

While there were three deaths from timbers and hand tools, 192 men were seriously injured by them. There is no branch of metal mining so important to successful operation as timbering and possibly no part of the industry has been neglected to such an extent as that of handling timber. Recently a collapsible timber setting derrick (Fig. 5) has been placed on the market and this may prove useful for raising and placing stulls and stemples, also in placing collars in timber sets. The Eureka Timber Hook (Fig. 6) or "toad" for short.

Fig. 6. Eureka Timber Hook

may be used on the end of sticks to lift them or snake them along. Sometime probably small electric crabs will be devised to assist in handling timber in the mines; then there will be fewer falls of timber and fewer injuries from tools, and falls from staging.

In the Lake Superior region 13 were killed from explosives and 45 seriously injured, which shows that in this respect the operators are aware of the importance of properly handling this material. In Colorado in 1911, 43 were killed and 247

injured by explosives, and in 1912, 47 were killed and 435 injured. Some of the common accidents result from thawing dynamite over a candle, in a stove, by using too hot water or placing it on too hot sand; picking out missed shots; drilling into missed fire charges; using metal tools for ramming charges in holes; remaining too long after lighting fuse; returning too soon after blast had been lighted; flying rock from blast, men not being in place of safety; explosions from unknown causes; picking or mucking dirt in which was unexploded powder or caps; carelessness in handling and carrying caps and drilling in blownout shot holes.

Underground magazines are unsafe. Within the past few years one blew up in Park City, Utah; another on Treadwells Island, Alaska, and one in California. There have been others likely. No definite reasons for these explosions have been advanced, although lightning went down the same coal mine twice in two years and exploded black powder, also dynamite in holes which were connected to a battery.

Quite a number of accidents both fatal and non-fatal occur in chutes where men get drawn in when starting the ore running after a jam. This can be avoided by the use of ladders outside and inside the chute but not where a man stands on the ore and tries to bar a hole from above or gets below the jam and starts to make it move. Lake Superior mines are not alone in this matter of chute accidents inside and outside the mine, and some means should be devised to prevent them, for so long as rock will jam and arch, the chutes must be barred. A few dollars expended on a chute might possibly do away with these accidents.

While no fatal accidents are recorded from drilling machines 132 serious injuries are recorded. It is sometimes hard work to haul machines up a stope and sometimes difficult to keep them there, consequently every man for himself on this proposition until some one devises a remedy. Machinery other than drills and locomotives is responsible for the deaths of 5 and the injury of 60 men. Not knowing the kind of ma-

chines connected with these accidents, one naturally wonders how men got against them or into them if they were fenced as machines should be.

Mine fires are miserable affairs and have caused great damage and expense more particularly in metal mines. It is possible that most of them can be avoided by using foresight, making rules and demanding their rigid enforcement. No steam pipes or electric wires should be allowed to come in contact with mine timbers. Miners should not be permitted to leave their candles or lamps burning in the mine, and should not attach them so close to timbers that the flames will scorch. Punk easily catches fire and in course of time creates a blaze. Pyrite can be ignited for which reason the lamps should be as carefully kept from pyritic rocks as from wood. Old timbers which have been replaced by new ones or are no longer needed should be removed from the mine. The reasons are they may trip some one, they are liable to catch fire; they will transmit fungii to sound timbers and will vitiate the mine air.

Rules of the mine should be printed and each man presented with a copy. Shaft rules and signals should be posted in the shaft house and at the landings.

To protect life and avoid accidents all hands from the manager to the nipper should regulate their actions to conform to the rules of the mine and neither do or leave undone anything liable to cause an accident.

The Prevention of Overwinding.

A device to prevent overwinding demands that the control of a hoisting engine be taken out of the hands of the engineer if the cage passes a certain point, say 3 or 4 feet above the landing. Such a device must shut off the steam and apply the brake instantly so that the cage shall not travel more than from 10 to 15 feet before it is brought to a stop, and held in suspension above the shaft. C. R. Welch has made a simple device of this kind which consists of a few valves, levers, a ram, some pipes and a weight.

There is a revolving hub having projecting arms which travels to the right on a threaded shaft when the cage is ascending and to the left when it is descending. The length of the horizontal movement of the hub is proportioned to the exact distance from the bottom to the top landing, and should the cage travel 3 or 4 feet above the top landing, the arms on the revolving hub will strike a lever which opens a valve and sends steam to a ram whose piston puts on the brake and closes the throttle almost instantaneously, thus preventing overwind-

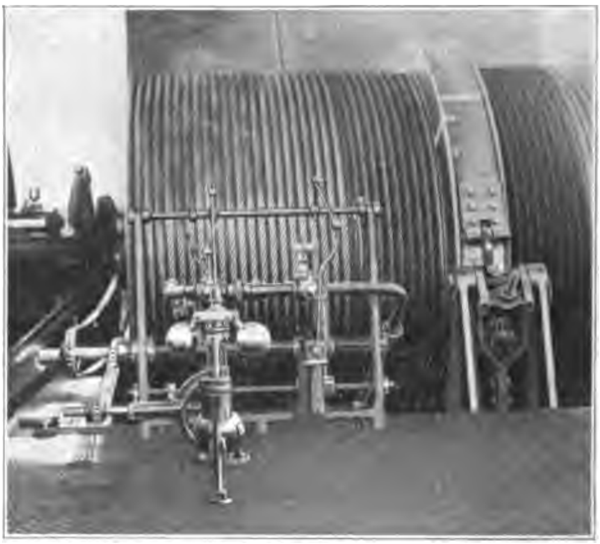


Fig. 7. Overwinding Device.

ing. The engineer has no volition in the matter, the control of the engine is out of his hands, and before he can recommence hoisting he must reset the device which prevents overwinding.

There is a regulator on this machine which, should the engineer fail to slow down as the cage reaches a certain point near the top of the shaft, will by the increased speed of rotation raise a weight and shut off the steam, also apply the brake.

The apparatus which is shown in Fig. 7 occupies little space on the floor and is a positive check on overwinding. The

only possible way to prevent its stopping the engine in case of overwinding would be to shut the steam off from it. Its very simplicity recommends it. When hoisting in balance, the two drums being fixed on the same shaft, but one overwinding device is needed because both cages travel specified distances relative to each other.

If, however, one drum is fixed and the other loose, or if drums are loose on the shaft to hoist from different levels, two devices are required, one for each drum. The drum shaft is connected to the overwinding device by a sprocket chain, and the regulator to the overwinding device by another sprocket chain. In case the drums were loose on the shaft the overwinding sprocket would be fastened to the drum.

Safety Gates for Shafts.

To prevent shaft accidents at the surface a gate of simple construction is used by the D. L. & W. Coal Company,

Fig. 8. Safety Gate, D. L. & W. Coal Co.

that may be raised or lowered into position before the shaft opening, by the cage as it comes to or leaves the surface landing. (See Fig. 8). It is a double gate, that is, it is constructed the same for each side of the shaft and is raised by the top of the cage striking against the two wooden cross pieces "A" fastened to both gates.

Fig. 9 shows the gate raised. Two iron guide rods "B" one each side of the gate keep the gate from swinging or swaying when the cage strikes the cross beams and also causes it to seat properly. To take up the shock of seating there are

Fig. 9. Safety Gate Raised, D. L. & W. Coal Co.

Fig. 10. Safety Gate, Pennsylvania Coal Co.

two coil springs "C" which answer every purpose. Because the ends are boarded there is no way for a person to fall into this shaft unless he climbs the gates.

Another safety gate is shown in Fig. 10. This gate is used at Pennsylvania Coal Company's No. 1 Dunmore shaft where the landing is on a high steel trestle and landers must at times cross the cage opening. The horizontal gate is raised and lowered by the top of the cage and both gates are always over the openings except when one of the cages is at the landing. The shaft collar at the surface of this mine is fenced on four sides and these fences must be removed by some one in authority before a person could fall down the shaft. It will be noted that these gates are worked automatically so that

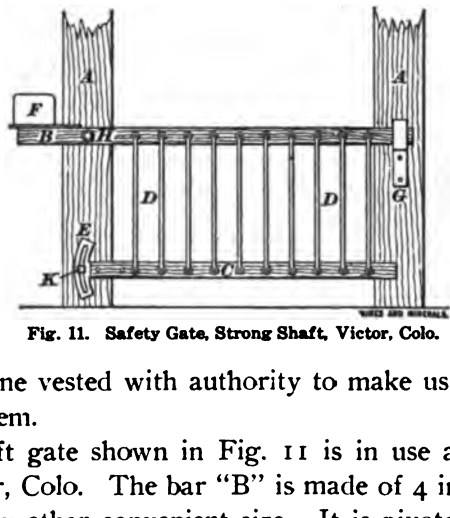


Fig. 11. Safety Gate, Strong Shaft, Victor, Colo.

only some one vested with authority to make use of the cage can raise them.

The shaft gate shown in Fig. 11 is in use at the Strong shaft, Victor, Colo. The bar "B" is made of 4 in x 8 in. timber or of any other convenient size. It is pivoted at "H" by a bolt upon the head-frame leg "A" and at the opposite end fits into the rest or catch "G" of ½ in. x 3 in. iron. "F" is a counterweight of the proper heaviness and distance from "H" to permit of the gate being raised or turned on the pivot "H," by a very light upward pull.

Suspended from the bar "B" by means of the rods "D," etc., is the lower bar "C" which may be made of lighter material than "B." The rods "D," etc., are flattened at the upper

and lower ends and bolted to both "B" and "C" so that they may turn freely.

Attached to the inner side and on the left end of the bar "C" is a slotted plate of thin iron, through which the bolt "K," set in the leg "A" passes.

When the bar "B" is raised by an upward pull near "G" it revolves on the bolt "H," and rods "D," etc., turn on their upper and lower pivots and the plate "E" turns downward on

Fig. 12. Shaft Gate Locking Device, H. C. Frick Coke Co.

the bolt "K," the whole gate being raised and folded like a ferry boat gate. The arrangement is very simple and can be made by any mine carpenter at a reasonable cost.

As gates of this description can be interfered with, the H. C. Frick Coke Company have adopted safety catches and locking device.

With the shaft gate locking device shown in Fig. 12, it is impossible to open the gate in the railing about the top of

the shaft unless the cage is there. The latch can be raised only by a system of levers operated by a handle extending through the fence just beside the gate; and it is only when the cage is in position at the surface that the proper bearing is afforded to the levers so that the latch can be lifted. On the shaft framing at the ground level is fastened a horizontal plate—an L-shaped lever turns about a pin in this plate. The lever arm is ordinarily back from the shaft out of the way of the cage, but when the cage is present one arm may be turned so as to bear against the side of the cage; the other arm being connected by a straight rigid link to the lower end of an upright lever, to the upper end of which is fastened the rod and handle to operate the gate latch, and which ordinarily, when the cage is not present, turns about a pin held by a heavy weight about 10 inches from the lower end. If now the upright lever is pulled with the cage away from the landing the L-shaped arm is simply turned forward and one arm extends out over the shaft; but if the cage is present the L arm can turn only until it hits the side of the cage when the lower end of the upright lever is prevented from further movement by the rigid link and the weight is lifted by any further pull. The gate latch is connected by a simple system of levers to this weight, holding the gate locked except when this weight is moved by the lever only when the cage is present.

It is proposed to connect this device also to operate a car stop so that it will not be possible for a car to run to the shaft except when the gate is open, the cage in position and ready for the car. The car stop prevents heavy cars from running into the gate.

The D. L. & W. Coal company have a combination of a gate which is lifted up by the cage and for a special reason can be made to swing open when the cage is not at the landing. It may be understood that in some instances this double arrangement may be valuable but as a rule the positive opening and shutting of the gate by the cage will prevent accidents.

The writer has been unable to find or hear of any automatic shaft gates used on levels underground. In the anthracite fields the gates on levels swing on hinges, and are operated by the lander who opens and shuts the pair on his side of the shaft and by the loader who does the same on his side.

CONCENTRATING AT THE MADRID MINE.

BY BENEDICT CROWELL, CLEVELAND, OHIO.

The Madrid mine, Virginia, Minn., has an output of about 400 tons per day. The ore requires concentration to produce a commercial grade, both as to the chemical analysis and the physical structure of the ore. The problem of cheaply concentrating this small output seems to have been successfully met by the introduction of the Wetherbee concentrator, which has been working sucessfully for some time past.

The concentrator is installed in the headframe, just below a pocket which receives all of the material that passes through a one-half inch screen. This amounts to about 50 per cent. of the ore hoisted. The coarse ore does not require treatment, and goes direct to the shipping pocket. The concentrator receives the material that has passed through the one-half inch screen, and discharges the concentrates which have been unwatered by a perforated bucket elevator into the same pocket that receives the coarse ore.

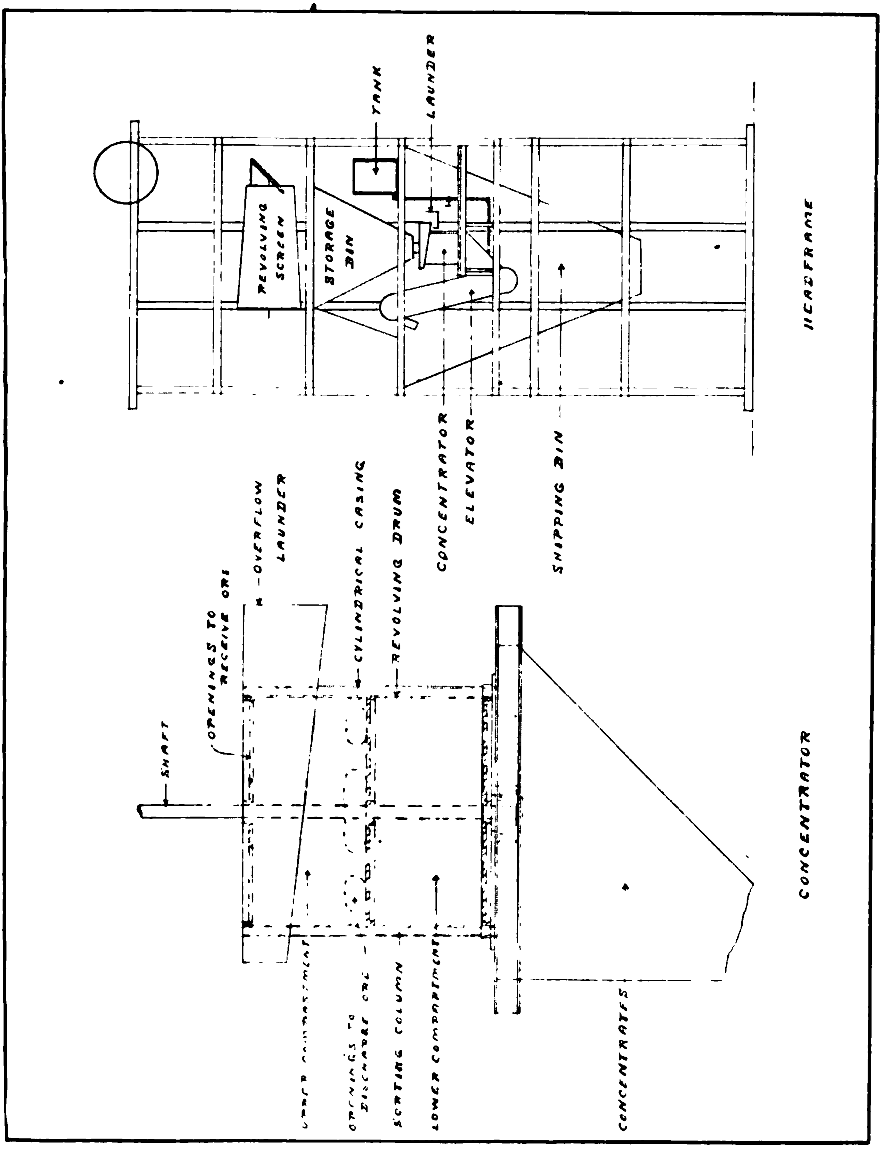
The concentrator is 3 feet in diameter, and is 6 feet high. It requires less than 1 horse power to operate and receives 6.5 gallons of water per minute, the water being pumped as needed from the sump in the mine to a small storage tank in the headframe. It is operated less than one-half of the time to take care of the output of the mine, and requires only one man in addition to the regular lander.

The output is desirable, both as to analysis and structure. It carries less moisture than the original ore, as all of the material that has been removed will pass through a 100 mesh screen, and this material increases the power of the ore to

hold moisture. The concentrates average about 57.50 per cent. iron, and the tailings about 40.00 per cent. iron. The recovery is about 84 per cent. of the material treated, or 92 per cent. of the total hoist.

The machine consists of a cylindrical drum and a cylindrical casing, the axis of the drum and of the casing being concentric and vertical. The drum is driven from above, and is made with two compartments, the lower of which is an air chamber that causes the drum to just float in water. The upper compartment receives the material to be washed, and discharges it by centrifugal force through openings into the annular space between the drum and casing. The casing has an overflow launder at the top, and is belted at the bottom to a water tight compartment, that is connected with the boot of the elevator. The water required enters at the base of the machine, and rises through the annular space between the revolving drum, and casing, and discharges into the overflow launder at the top of the casing.

The principle of the machine is based on the following theory: Supposing a particle of ore and a particle of quartz were allowed to settle in still water for a certain length of time, and that the particle of ore settled 4 inches, while the particle of quartz was settling 2 inches—it is evident that in order to separate these two particles by an upward flow of water, that a velocity of somewhere between 2 and 4 inches would be required or, say 3 inches a second. Assuming that these same two particles were placed in the machine, and the revolving drum given such a velocity that the quartz particle remained in suspension, traveling in the same horizontal plane, the ore particle, in the same length of time, would settle, say 1 inch. It is then evident that the slightest upward flow of water would wash out the particle of quartz, and would still allow the particle of ore to settle and that we have secured the same result by the use of the machine with an upward flow, of say, one sixteenth of an inch a second, that we did before with a flow of 3 inches a second, or in


TANK
LAUNDER
REVOLVING SCREEN
STORAGE BIN
HEADFRAME
CONCENTRATOR
ELEVATOR
SHIPPING BIN
SHAFT
OPENINGS TO RECEIVE ORE
OVERFLOW
LAUNDER
CYLINDRICAL CASING
REVOLVING DRUM
OPENINGS TO DISCHARGE ORE
SORTING COLUMN
LOWER COMPARTMENT
CONCENTRATES
CONCENTRATOR

other words, with the use of one forty-eighth of the amount of water. The fact that the whirling current can be controlled independent of the velocity of the upward rising current allows an exact and independent control over the material that goes into the overflow or into the concentrates by changing either the speed of the drum, or the amount of water used.

The capacity of this machine has not yet been tested at the Madrid mine, owing to the inability of the mine to hoist enough ore to make such a test. Twenty-five tons per hour has been put through, however, which is equivalent to say, 500 tons per day. The larger size machines, now being constructed, will greatly increase this output.

The Wetherbee concentrator was designed primarily to treat the sandy ores on the Western Mesaba range, and a number of tests have demonstrated that these ores can be concentrated up to nearly 60 per cent., the tailings consisting of fine material, that will pass through a 100 mesh sieve, running about 40 per cent. in iron, in other words, material that would make flue dust.

MINING METHODS ON THE MISSABE IRON RANGE.

BY COMMITTEE, CONSISTING OF WILLARD BAYLISS, E. D. M'NEIL AND J. S. LUTES.

The ore bodies of the Missabe Range are essentially flat deposits, of great area as compared to their depth. As an illustration, one of the larger deposits, located near Chisholm, has been proved by the drilling on contiguous forty-acre tracts to be two and one-half miles in length, and to average three-quarters of a mile in width. Within this area, however, there are some isolated barren portions where ore concentration has not taken place. This ore body is overlaid in some places by slate or taconite and glacial drift; in others, by glacial drift alone. The average of 202 drill holes through to the bottom of the ore was 58 ft. of ore and 76 ft. of glacial drift and rock above. The depth of ore ranged from 5 to 243 ft., while the glacial drift and rock ranged from 11 to 215 ft.

Taking the whole range into consideration, it may be said that the ore bodies are generally less than 200 ft. thick, with a maximum of 500 ft.

Mining Methods in Present Use.

There are three general methods in use at the present time in mining these ore bodies, viz:

1. *Underground Mining*—The ore being mined by hand and hoisted through a shaft, the underground openings being supported by timber.

2. *Open Pit Mining*—Where the material above the ore body is first removed and the ore then mined by steam shovels and loaded direct into standard-gauge railroad cars.

3. *Milling-Pit Mining*—A combination of the two for-

mer methods, the material above the ore body being first removed, after which the ore is mined through underground openings and hoisted through a shaft.

SELECTION OF METHOD OF MINING.

The selection of the method of mining to be adopted involves a great many considerations and calls for experienced engineering and business judgment. Regardless of the method to be adopted, its selection should be preceded by thorough drilling to determine the limits and size of the ore body and the grades of the ore. Maps showing the top and bottom contours of the ore, and cross-section maps shownig relative thickness of stripping and ore are indispensable. It is not the intention of this paper to go into the subject of the costs of mining, but in order to show the basis on which calculations are made, we quote the following from "IRON MINING IN MINNESOTA," by Charles E. Van Barneveld.*

"*Operating Estimates*—When a property has been drilled and estimated, the engineer makes further estimates to determine the method of mining best suited to the ore body under consideration. The following basis has been established for comparison of underground and open pit mining costs:

TABLE NO. 1.

Stripping ordinary glacial drift, 30 cents a cubic yard.
Stripping ordinary paint-rock, 30 cents a cubic yard.
Stripping ordinary broken taconite, 75 cents a cubic yard.
Stripping ordinary solid taconite, $1.00 a cubic yard.
Steam shovel mining, ordinary ground, 15 cents a ton.
Underground mining, ordinary conditions, 75 cents a ton.
One cubic yard of ore is roughly 2 tons.

Sometimes a glance at the ore estimate will suffice to classify part or all of an ore body. Often a calculation must be made as exemplified by this case: A drill hole shows 50 ft.

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of ordinary glacial drift and paint rock, 15 ft. hard taconite, 36 ft. merchantable ore.. All other things being equal, is this an open-pit or an underground proposition?

Reducing the consideration to a column of one yard square at the drill hole, a comparison may be made using the data in Table No. 1.

Underground Mining—

Cost of mining a column of ore 1 yd. square and 36 ft. high at 75 cents a ton (1 cu. yd. equals 2 tons), 36/3x2x$0.75=......	$18.00
Open Pit Mining—	
Stripping a column 1 yd. sq. and 50 ft. high of glacial drift at 30 cents a cu. yd., 50/3x$0.30=..	5.00
Stripping 15 ft. solid taconite at $1.00, 15/3x$1.00=..	5.00
Steam shovel mining 36 ft. ore at 15 cents per ton, 36/3x2x$0.15=...	3.60
Total cost of open pit work..................	$13.60
Difference in favor of open pit..................	4.40

* * * *

This offers a ready method of preliminary comparison to be supplemented by more exact figures when special considerations enter. It is of course understood that such questions as adverse or favorable topography, accessibility of dump room, quick-sands, swamps, etc., have a special bearing on each individual case that does not admit of generalization.

The economical limit of stripping is at present considered to be within the following proportions:

1. One yard of overburden to 1 ton of ore.

2. Not to exceed 2-ft. depth of overburden to 1-ft. depth of ore. Hard slates and taconite cost from 2 to 3 times as much to strip as ordinary glacial drift and it is customary when applying these figures to consider 1 ft. of such material as equal to 3 ft. of overburden.

3. A maximum stripping depth under any considerations of 150 feet."

In general, underground methods are used for those ore bodies lying under slates or taconite, or deep glacial drift. It is an alternative method, adopted only when the other two methods are out of the question. About the only consideration in its favor is that production can be obtained quicker and with less initial cost than with the other methods.

Open pit mining is used for the larger bodies of ore lying under comparatively shallow surface material and where the operating company is able to make the large initial expenditure in stripping. Besides permitting the lowest operating cost, it has many other advantages. The capacity for production from an open pit is enormous as compared to a shaft. One forty acre tract opened up as an open pit, provided the approach can lie on adjoining land, operating with two shovels and five locomotives, can send forward 9,000 tons daily, while the same area being operated as an underground mine, hoisting through one shaft, would ordinarily produce about 2,000 tons daily.

The milling pit method of mining is adopted generally for the smaller bodies of ore lying under comparatively shallow surface material. The amount of initial expenditure for stripping is much less than for an open pit, where the cost of the approach is a large item. The cost of production from a milling pit lies between that of open pit and underground mining.

Underground Mining.

There is one prevailing method of underground mining in use on the Missabe Range at the present time. This is the Top Slicing or Caving Method. The main points of this method are as follows:

A top slice over the whole area of the ore body is removed, using timber to the full height of the ore. As fast as the various rooms of this top slice are worked out, the bottoms are covered with boards, and the timber is blasted down, allowing the overburden to cave and fill up solidly the space formerly occupied by the ore.

When the top slice is out, another slice over the whole area is taken out just below it, also using timber the full height of the slice, up to the boards of the slice above. Rooms are blasted in as fast as they are mined out and the cave follows. Successive slices are taken in like manner to the bottom of the ore body. The use of timber to the full height of the ore in each slice, thus insuring a very high percentage of extraction, is the most important feature of this method. The cross-cuts to the various rooms are always in solid ground, providing a safe retreat for the miners.

The general practice in opening up and mining an ore body to be worked on the Top Slicing system may now be briefly considered.

Size and Location of Main Shaft—For an ore body of considerable size, a shaft 8 by 20 ft. outside is largely used. There are two skip compartments, 5 by 6 ft., and one ladder and pipe compartment, 6 by 7 ft. with 6 in. dividers. The sets are of 12 by 12 in. timber. The shaft is located near the deepest part of the ore body, either in the ore itself or in the adjacent rock. From this position the drainage of all the ore to be mined through the shaft may be taken care of.

Timber Shafts—Usually the sinking of a timber shaft, somewhere near the main shaft, is begun at the same time as the latter. From one to three additional shafts, depending on the size of the mine, are sunk at advantageous points. The size may be 6 ft. square, or 6 by 9 ft.

Location of Main Drifts—A close study of the bottom contour map is necessary to decide this point. Where the drilling has been sufficient, one or more troughs of deep ore will be found running through the ore body, generally from northwest to southeast, or from west to east, with the deepest part of the trough at the easterly end. It is in these troughs that the main drifts are located. The chief considerations are to have them near the bottom rock and still have them extend as near to the limits of the ore body as possible. The idea is to make the motor tramming long and the hand tram-

Top Slicing Method—Room Two Sets Wide, Showing Bottom Covered and Sides Partly Boarded Up.

Drift Slice, Top Slicing Method

Square-Set Slicing, Room Two Sets Wide and Two Sets High.

ning short. When an ore body is 50 ft. thick or more, it is good practice to locate the main level high enough up in the ore body so that it will extend a considerable distance from the shaft, another main level being opened up nearer the bottom later. If the ore trough is wide enough, two parallel drifts, from 60 to 100 ft. apart, are driven, connected by a loop near the shaft. The advantage of two drifts is in opening up the ground quicker for drainage; small drifts across connecting them improve the ventilation; if one strikes rock unexpectedly it can be discontinued temporarily, while the other continues ahead, from which exploration of the rock encountered can be made. The main drifts are timbered with sets 5 ft. apart, using 8 or 9 ft. posts and 10 or 12 ft. caps, with lagging over the back. Vertical raises, 4 ft. square and without cribbing, are put up every 50 ft. along the main drifts and carried up to the top of the ore.

Top Sub-Level—(See Fig. 1, which also shows plan of main drifts and raises.) The Top Sub-Level is located at such an elevation that the average height of the ore to be removed will be from 12 to 14 ft., so that most of it can be taken out with drift sets. From each raise 5 by 6 ft. drifts, untimbered, are driven parallel with each other and at right angles to the main drifts, until they reach the limit of the ore body or the boundary line of the property. Here the stoping or slicing of the ore begins.

Slicing Details—Fig. No. 2 shows plan of two adjoining rooms each 50 ft. long and 15 ft. wide, opened up at the boundary line, together with a cross-section through one of them. When the boundary line was reached by cross-cut No. 1, the first drift slice was started by blasting out all the ore at set marked No. 1, and sets of timber, (12 ft. posts and 7 ft. caps), with the caps parallel with the cross-cut, put in place, using 6 ft. lagging overhead. Set No. 2, also in the cross-cut, is the next to be taken and securely timbered and spragged, thus making the entrance secure. These four sets of timber at the entrance of the two slices of a room or stope are usually re-

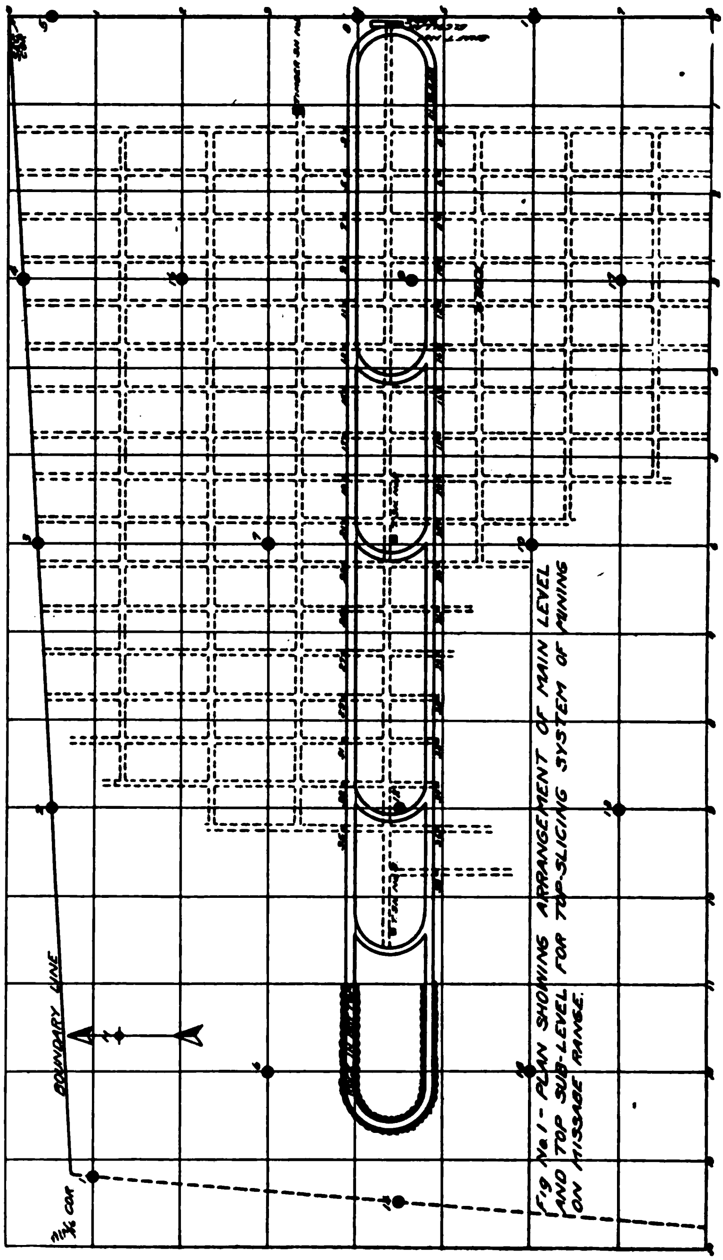

Fig No 1 - PLAN SHOWING ARRANGEMENT OF MAIN LEVEL AND TOP SUB-LEVEL FOR TOP-SLICING SYSTEM OF MINING ON MISSABE RANGE.

ferred to as the "open sets." The first slice on the long side of the 50 ft. room is now completed by taking out sets 3 to 9. The track is continued from the cross-cut into this slice as it advances. The next sets to be taken out depend upon whether the timber is taking much weight or not. If it is not,

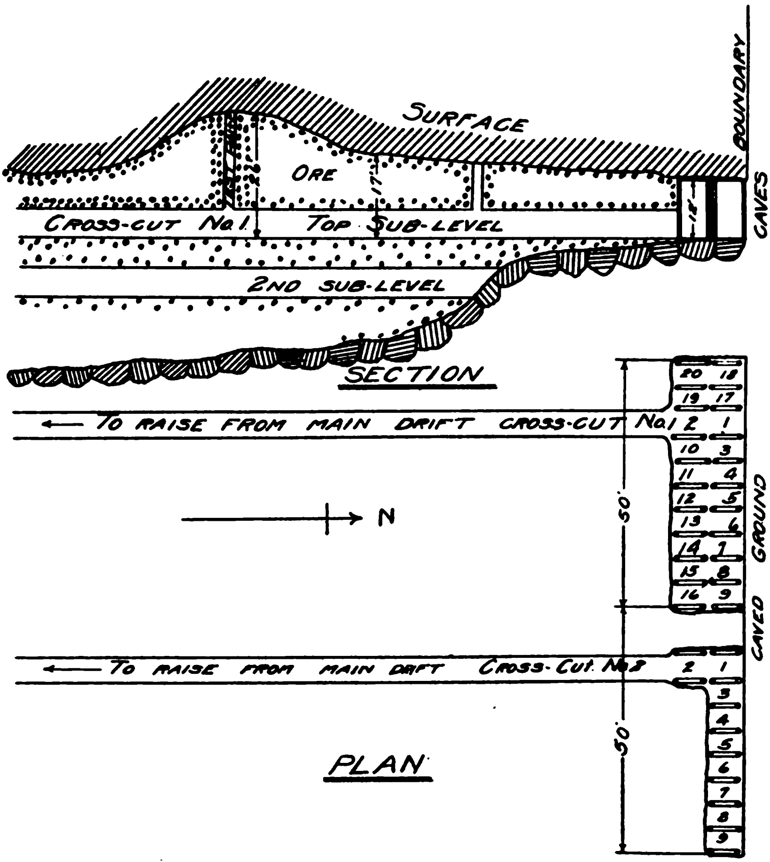

FIG. No. 2. TOP SLICING ON MISSABE RANGE

sets 10 to 16 are consecutively mined out, completing the long side of the room. The short side of the room is now taken out in the order indicated (sets 17-18-19-20). On the other hand, if the room is heavy and timbers are taking considerable weight, the order of removing the sets must be changed. A

safe exit for the miners must be maintained and it would be inadvisable to weaken the entrance to the room by taking out set No. 10 at this time. The slice would be worked out from the far corner retreating toward the cross-cut. Instead of taking set No. 16 first, however, the miners make their attack on set No. 15, because it would blast out a little easier and there would be more room for them to shovel into the tram car standing on track in set 7 or 8. Therefore the sequence of sets taken out would be 15-16-14-13-12-11. Set No. 10 is left standing to protect the entrance while the short side of room (sets 17-18-19-20) is next mined out, and is the last set to be taken. This order of working out a room is not invariable, many changes being made depending on differing conditions. Under a strong back, or with solid ore on both sides of a room, the ore would be taken out two sets wide from the cross-cut back to the far end. Again, when the preceding room has not filled up solid with the cave, sets 10 to 16 would be taken first, leaving one set of solid ground against the unfilled cave, after which sets 9 back to 3 would be taken.

The reason for having a long side and a short side to a room is that only one set of curved rails need be laid to get tram car to convenient shoveling distance for all the sets. The track is laid in only one of the slices. The ore from the short side is shovelled into car standing in the cross-cut.

When a room is worked out, the side and ends next to the solid ore are boarded up with cull boards to prevent the sand from mixing with the ore of the next room when it is mined. The bottom is also covered with boards if there is a slice to be taken out underneath. The double row of posts in the center, and those along cave side, throughout the length of the room, are blasted out and the caved ground follows and fills the room. There is usually no difficulty at this point, the room soon being filled up solid against the boards so that another slice may be started alongside after a few hours.

The height of the ore on the top sub-level varies consid-

erably on account of the rolling back. The length of posts used in the successive slices must be changed accordingly. The limit to successful slicing with drift sets is reached when posts 16 ft. long are necessary. Rather than use such long posts to any considerable extent recourse is usually had to using square set timber, two sets high, which would take out the same height of ore.

Square-Set Slicing—In the cross-section in Fig. 2, a test raise is indicated which shows a roll in the back making maximum height of ore 26 ft. above the top sub-level. Rather than open up a sub-level of very limited area in the upper half of this roll, in order to remove the ore with drift timber, it is the usual practice to mine it all out on square-sets. The change from drift slicing to square-set slicing would begin where the height of ore shows 17 ft. The first square-set slice would be taken in the solid, that is, leaving one set of ore standing between it and the last drift-slice. This is to insure getting the line of the square sets straight and at right angles to the cross-cut. The two sets in height of this slice are both mined out and timbered as the slice advances. The pillar left standing next to the drift-slice is then mined out and timbered, the order of removal of the sets depending on whether the ground is heavy or not. The long side and the short side of the room being mined out, the side and ends next to ore are boarded up in same manner as a drift slice, except that lagging instead of boards is used on the bottom set. This is because they are stronger than boards and there is more pressure from the cave on account of room being higher. The span between sets is also greater. The rooms are blasted in as soon as the timbers show that much weight is on them which usually occurs when they are two sets wide. The blasting is done in such a manner as to leave the timber undisturbed which stands against the solid ore.

In the succeeding square-set rooms the first slice is taken out along the cave, the caps connecting with the timber of the previous room. There are usually 5 sets on one side of the

cross-cut, and one set on the other, which, with the set occupying the cross-cut itself, makes the total length of room 7 sets or 51 ft. 8 in. A cap of odd length is used in connecting the timbering of rooms joining each other on their ends.

Bottom posts are 8 ft. over-all, with 4 in. tenon. Regular top-posts are 8 ft. over-all with two 4-in. tenons. Top-posts of lengths varying from 4 to 12 ft. are used on the top set where the back is irregular. The regular cap is 7 ft. long.

There is very little square-set slicing on the Missabe Range at the present time exceeding four sets in height. Higher than this a great deal of trouble is experienced in keeping the rooms in shape on account of the pressure of the caves. Where the ore on the top sub-level is found to exceed this height it is divided by opening up another local sub-level and mined out with drift timber.

Square-set slicing should be distinguished from the well-known square-set system of mining, where alternate pillars of ore were left standing between large square-set rooms, to be mined out after the latter were caved and filled.

Prop Slicing—There are extensive stretches of ground in many of the Missabe mines where the ore is overlaid by firm taconite or slate. In such cases the top slice can be taken out with the use of props, spaced irregularly as required. The maximum height of props used is 20 ft. Often the ore does not exceed this height and, consequently, can all be mined out in one slice. Where such conditions occur the cost of mining is considerably lessened.

Second and Lower Sub-Levels—When the ore in any part of the top sub-level has been mined out back to 20 ft. from the raise from main level drift, a second sub-level is opened up by starting another cross-cut from the raise, directly under the one above, and of the same dimensions, 5 by 6 ft. Parallel cross-cuts on the same level are driven from each raise as other places above are finished. The distance below the bottom of the top sub-level at which these cross-cuts are

started depends on the total thickness of the ore down to the main level, measured from bottom to bottom. This total height is divided so that the sub-levels will be from 11 to 15 ft. high. Where 11 ft. must be selected there would be 5 ft. of solid ground over the back of the second sub-level cross-cut up to the boards of the top slice above. The ground is usually firm enough so that these cross-cuts will stand without being timbered. They are driven to the boundary line or until they strike the bottom rock, when slicing begins and is carried on in the same manner as on the top slice. The

Top Slicing at Edge of Leonard Open Pit.

rooms are timbered right up to the bottom boards of the slice above.

In conclusion, the Top-Slicing or Caving method of mining can be adapted to all conditions met with in underground mining on the Missabe Range. It is favored alike by fee-owner and operator, for in these days of rapidly diminishing ore reserves, wasteful methods of mining are no longer tolerated. In any method of mining, the safety of the miner should be the first consideration; the conservation of the ore, the second. This system has both of them to recommend it.

Open-Pit or Steam Shovel Mining.

Open-pit or steam shovel mining applies to that system of mining where the ore from an open pit is loaded by steam shovels direct into railroad cars. It has been likened to loading a stockpile, beginning at the top.

The first shipments from some Missabe Range mines have been fully as simple as stockpile loading but as depth is reached, approaches, grades of incline, and lay-out of tracks to reach the various parts of the ore body require skillful engineering.

As mentioned elsewhere in this article, this system is the cheapest method and is adopted wherever it appears practicable. Recent practice shows the use of open-pit mining for ore deposits that were formerly considered underground propositions. In fact, some mines that were opened as underground propositions have been changed to the open system, notwithstanding the fact that a considerable tonnage of ore had already been removed and that stripping and mining both presented conditions less favorable than before underground mining was undertaken.

Among the mines originally operated by underground mining and later changed to open-pit methods is the Commodore Mine at Virginia. It consists of one forty and is surrounded by the Lincoln, Union, Lone Jack and Missabe Mountain properties. Seven hundred thousand tons had been mined through underground operations when it was decided to change to open pit mining. Adequate and suitable dumping grounds were difficult to obtain and to complete the stripping necessitated dumping 800,000 yds. on the Commodore forty, over one-half of which composed the stripping area of the open pit. The waste dump finally reached a height of 87 ft. and the height from top of ore at deepest stripping point to top of dump was 201 ft., showing that some of this stripping material was elevated in its transportation 201 ft., which was accomplished without going off the mine forty, except at the ends of two tail tracks where they ran on to adjoining

property. The tracks from shovel to dump consisted of four switch-backs on a 5 per cent grade.

The equipment was standard gauge dump cars and Shay geared locomotives of eighty tons weight on drivers. These locomotives are slower than the rod engines but have more tractive power, particularly on starting their loads on heavy grades and curves. In mining at this property both the rod type and Shay geared locomotives are used and a comparison of the two types under similar conditions shows the rod engines more satisfactory on good tracks and low grades, but on grades over 3 per cent and particularly where necessary to start the loads on heavy grade the geared locomotives had the advantage.

Limited area, depth and shape of ore deposit, yard facilities, etc., have made conditions at this property for steam shovel mining more severe than most open pits on the Range. The accompanying map shows the surface and pit lay-out. The approach is laid out on a 3 per cent grade which is equalized to allow for resistance on curves. During one season considerable loading was done on a 7 per cent grade, the Shay locomotives being able to start and haul three loads and the rod engines two loaded ore cars of forty tons each. A few years ago it was the practice to lay out open pits with grades not over two and one-half per cent, and with curves not exceeding twenty degrees. While it is very desirable to keep within these limits of grades and curves, nearly every mine has found it possible and necessary to exceed practical railroad conditions.

The actual loading of the ore by steam shovels is practically the same all over the Range. At some mines all the ore must be blasted in order to loosen it for better loading, while at other mines the shovels are able to handle the ore without any blasting.

Sixty to eighty-pound rails are used for mine tracks, the heavier steel being favored. The temporary loading tracks have to be changed for each succeeding shovel cut. At some

Hull-Rust and Mahoning Mines. Hibbing, Minn.

Monroe Mine

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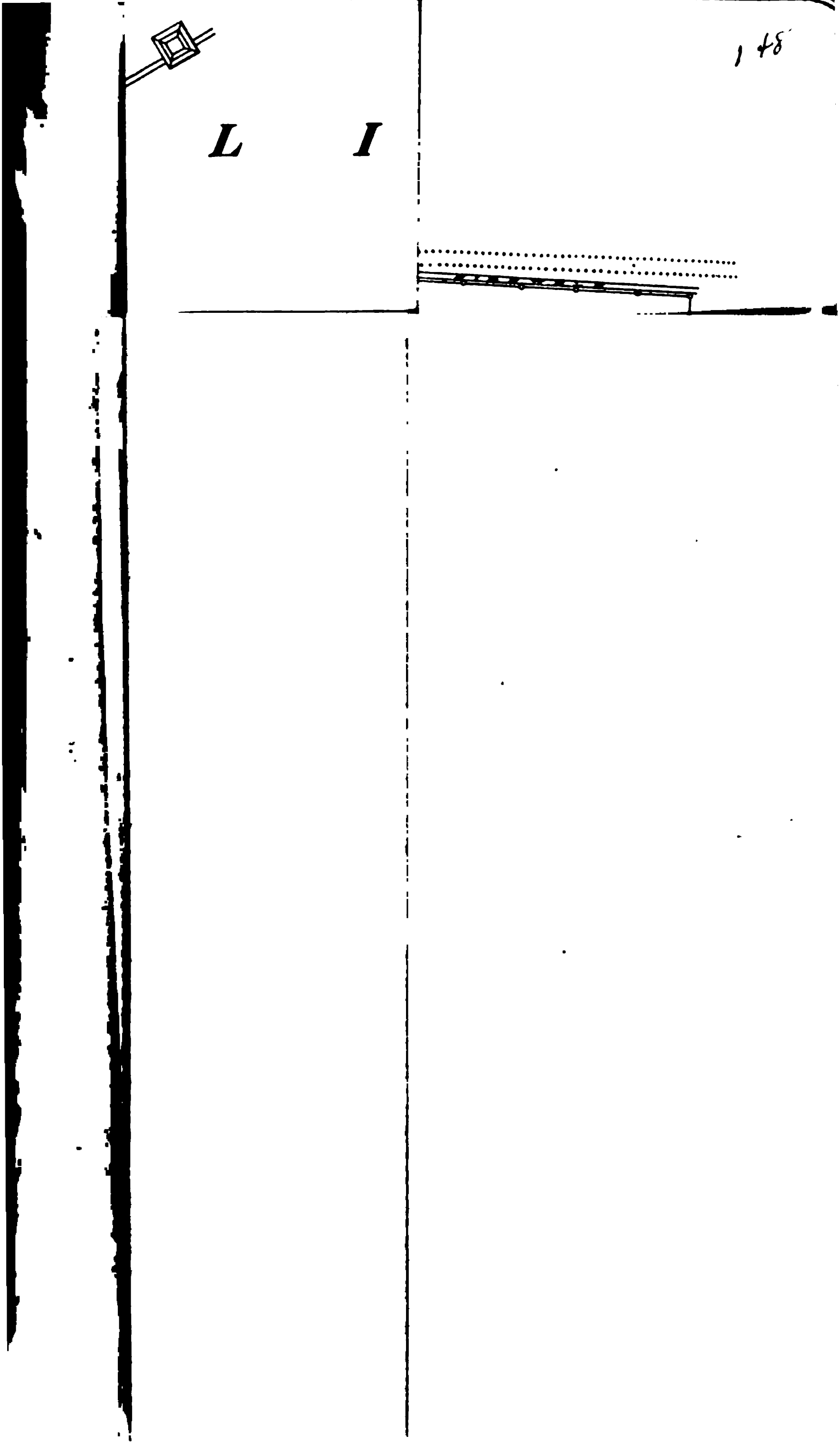


mines, and especially where the loading tracks are straight and of the lighter rail section, it is the practice to jack up the track to be moved and then line or heave it over with bars. At other mines new track is laid behind the shovel and in place for the next cut, the previous track being taken up.

There are several important special features in connection with open-pit mining of which mention should be made.

At the Biwabik mine which has the distinction of being the first mine on the Missabe Range to use the steam shovel, much of the ore, a high grade Bessemer, requires crushing. Recently a new crusher of the gyratory type, with a 48-in. receiving opening, has been put in operation. It has a capacity of 1,000 tons per hour and is the largest gyratory crusher that has ever been installed.

On the western end of the range, many of the ore bodies contain layers of fine sand, lean ore and broken taconite which must be separated from the ore in order to make it merchantable. After several years of experiment a large concentrator was erected on the east side of Trout Lake, at Coleraine, by the Oliver Iron Mining Company, which has been in successful operation since 1909.

The Wisconsin Steel Company erected a concentrator at Nashwauk, consisting of two units, which began operations in 1912.

At the Leonard, Shenango, Commodore and some other pits, low grade material containing 35 to 49 per cent iron is being stockpiled. This material is unmerchantable at the present time and being mostly paint-rock it will probably not yield to concentration.

At the Brunt mine, at Mountain Iron, a drying plant is in operation for removing the excess moisture from the ore The moisture is being reduced from 18 to 20 per cent down below 8 per cent, resulting in considerable saving in freight charges and rendering the ore more acceptable to the furnacemen.

Another drying plant is in course of erection at the Whitesides Mine.

Milling System of Mining.

The Milling System is adapted for mining of the ore from deposits favorable for stripping but where the size of the de-

Crushing Plant at the Biwabik Mine.

posit, or its location, is such as to make it impracticable to mine as a steam shovel proposition.

The relative depth of surface and ore, or rather the rela-

tive proportion of over-burden to be removed to the amount of ore uncovered, the size and shape of the ore deposit, the space and facilities for trackage approaches, and relative outlay for equipment and development, are the determining factors for choosing between the milling and steam shovel methods. What is termed the "Milling System" on the Missabe Range is in reality a form of what is termed "Underhand Stoping" on the older ranges, and the development is by shafts, tramming levels, etc., much the same as in underground mining. The overburden is removed from the surface of the ore which permits of the use of underhand stoping by working the ore into chutes, from which it is drawn out on the tramming levels and handled in the same manner as in other underground mining systems.

In opening up a proposition on the Milling System, the area to be stripped, the stripping approaches, location of shaft, shaft house, tracks and mine buildings are decided upon. The work of stripping or removing the overburden is usually the first work started, and while this is progressing the working shaft is sunk, tramming levels opened up and raises driven to the top of the ore deposit. Raises are usually 4 by 5 ft. or 5 ft. square, and are put up at intervals of from 30 ft. to 40 ft., and are equipped with chutes at the bottom. When ready to start mining, milling or underhand stoping is started by drilling holes around the tops of the raises and blasting them so that their burden will fall into the raises. After blasting, the loose dirt is usually picked down or loosened, or at least as much of it as will readily run into the raise, after which blasting is again resorted to. It is customary to drill what are usually called collar holes first; and then carry the stope up the bank by successive blasting and picking down the loose dirt as long as it will run into the raises. The Missabe Range ores are of such character as to break up quite fine and run readily at an angle of 45 degrees, and in dry weather the ore will run on a slope of 38 degrees. Results are best after the mills or funnels have been enlarged, and

the larger the mill the better. When blasting large quantities of ore, and particularly when starting mills, the ore from the blasted holes falls to the bottom of the raises with such force that it often packs so hard that it will not run out of the chutes, and causes what is termed a "hang-up." This necessitates the use of chute bars to loosen the ore and get it running.

Jordan Milling Pit, 1903.

It often happens that the ore continues to hang up higher than can be reached with bars, when other means must be employed. At the Monroe mine where the raises were very high, a system of sub-drifts were driven above the working level, connecting all the raises. This plan gave an opening for barring a hang-up raise through openings in the lagging

or raise cribbing. At the Albany mine the main level drifts were made two sets high opposite the raises or chutes. This permitted the use of longer bars and facilitated the process of barring. At the Iroquois mine they placed a chain or wire rope through the raise, and when hung up the rope or chain was pulled up by a small hoist and pulled down by a number of men standing on the level.

At the Jordan Mine the trouble with hang-up raises was obviated to a large extent by working down to the back of the tramming level the first two mills, and after that the raises were holed through into the sides of the slopes. The raises being from 30 to 40 ft. apart would hole through into the milling slopes when 30 to 40 ft. high. The first raises were 85 ft. high and caused a great deal of trouble with hang-ups. The subsequent raises being from 35 to 40 ft. high were much freer from hang-ups than the longer raises. By starting milling on the lower sides of the raises where they holed through into the slopes, the distance from the collar of the raise to the chute was seldom over 30 ft., and a hang-up could be broken down by barring or drilling from the top, if the trammers failed to get it running by barring from below.

Another plan adopted to some extent was to make the raises larger at the bottom and tapering upward, but the construction of the chutes permits the ore to accumulate back in the corners and the raise openings soon become smaller. While the hang-ups occur from the impact of the falling burden, resulting usually from blasting into the raises, the trouble from this source is contributed to by the raise opening becoming smaller and smaller, from moist ore accumulating and caking quite hard all around the raise. From time to time it is necessary to clean out the sides of the raises for a distance above the chutes.

The production by the Milling method is usually irregular and varies from day to day, being influenced largely by weather conditions, as well as by the steadiness of the labor employed. During a spell of nice weather and with full crew

of men, the daily production may be at the maximum, but a heavy rain drives home the men working in the mills and washes out the slopes, making holes and gullies in the mills, and blocking the chutes with loose ore and water. If much water collects in the mills and chutes, any attempt to open and draw the chutes results in a rush of sloppy ore and water, filling the level and necessitating cleaning up before tramming can be resumed. If the chutes are opened up more than two or three inches there is no closing them if the rush starts. In addition to the chute and level trouble, the slopes in the mills are so uneven and irregular that for several days much of the ore that is loosened by blasting or picking down, fills up the holes and gullies instead of running into the chutes. Dry ores naturally run much better in the mills than wet ones, and some ores that would run readily on a 45 degree slope during dry weather become soaked and will scarcely run on a 50 degree slope when wet.

When the mills are worked down close to the back of the level, short raises are put up in the ridges and much of the remaining ore is milled in that way. At some mines steam shovels have been used to dig the ore in the hog-backs or ridges and drop it into the mills. This process was further developed, using the steam shovel to load the ore into cars which were either dumped direct into the skip pocket, or through a transfer chute and then re-trammed to the shaft.

The Milling System is also used for the lower parts of ore bodies opened up for steam shovel mining, when the depth renders the use of locomotives impracticable. This system permits the recovery of all the ore, is more economical than underground mining and is, perhaps, a little safer. It is subject to the accidents incident to the limited underground work and blasting in the open, but the greater danger is from men being carried into chutes by slides. This is guarded against to some extent by the use of ropes.

The Milling System has been used at the Norman, Auburn, Fayal, Adams, Sharon, Jordan, Albany, Monroe, Duluth, Leonard, and a few other mines.

WASH ORES OF WESTERN MISSABE RANGE AND THE COLERAINE CONCENTRATING PLANT.

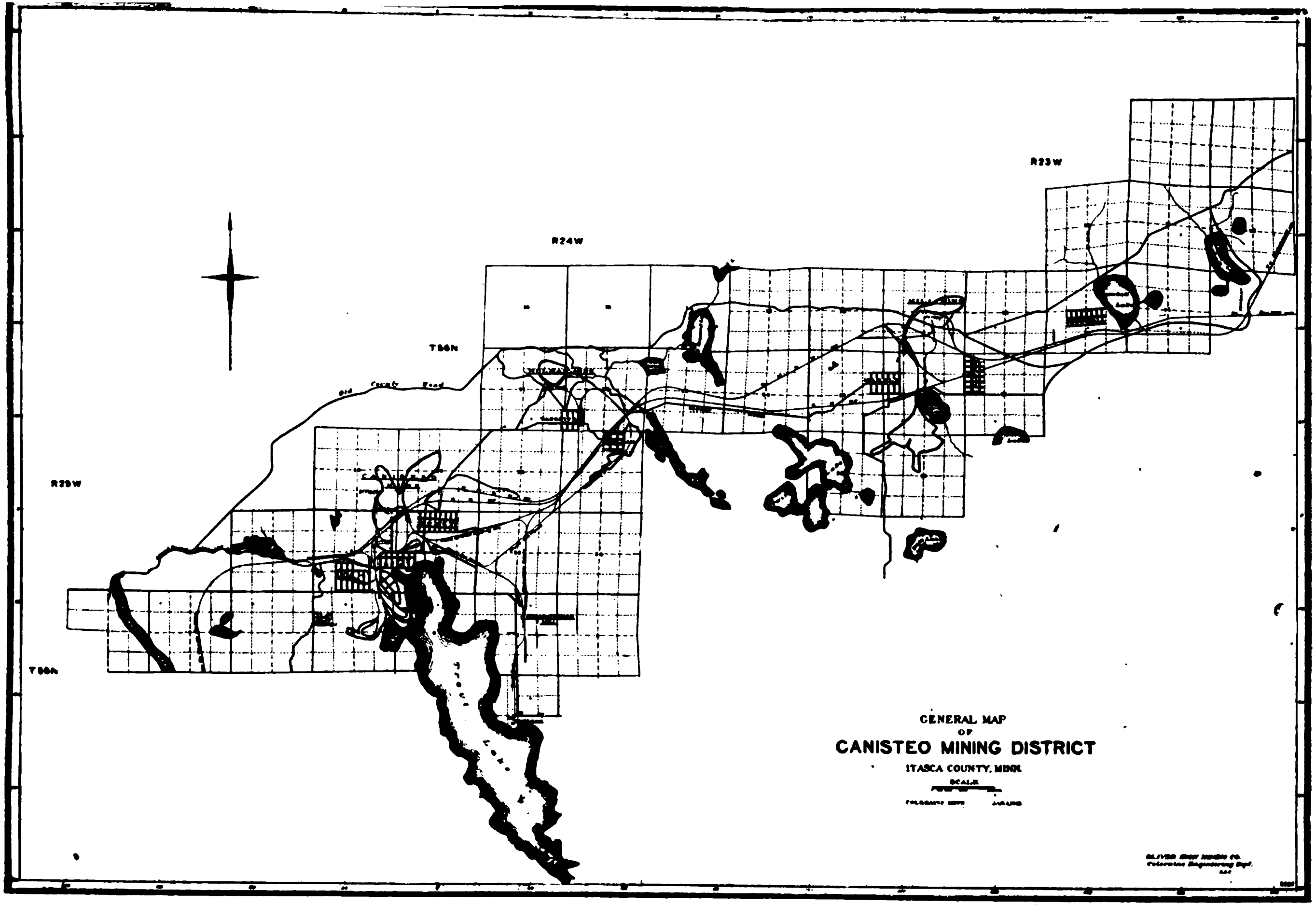
BY JOHN UNO SEBENIUS, DULUTH, MINN.*

CHAPTERS.

*Chief Engineer, Mining Department, Oliver Iron Mining Co.

Views, Photographs Nos. 1 to 13 inclusive, showing outside view of Coleraine Plant itself and the

suit is our high grade merchantable ores, but where conditions for this process of change and disintegration were not entirely favorable, nature did not carry out its work to completion. Hence on the Missabe Range we find gradations all the way from the original "greenalite" as the extreme on



R23W
R24W
T56N
R25W
T56N
Old County Road
Trout Lake
GENERAL MAP
OF
CANISTEO MINING DISTRICT
ITASCA COUNTY, MINN.
SCALE

one hand to the high grade ore on the other. The conditions affecting the efficiency of the process for the time it prevailed were largely such as offered the underground waters, which acted as the main agency in this important change, opportunities for perfect percolation and circulation. In viewing the Range with these conditions in mind it seems that over the eastern portion, extending from the eastern limit as far west as a mile east of the D. & I. R. R. R. track, conditions were evidently not favorable for a perfect change, and we therefore now find a hard lean iron formation practically barren at present, as far as known today, of merchantable deposits of any size, together with some lean silicious material; whereas in the middle portion of the Range, extending over an area lying approximately between Sec. 22, 59-14 and the center of Sec. 23, 57-22, we find merchantable ore bodies of large size occurring in a rich largely altered formation, together with a considerable amount of low grade merchantable and non-merchantable silicious ore material as a connecting link between the formation itself and the high grade ores. Again, on the western end of the range, extending from the central part of Sec. 23, 57-22 to about twenty miles west of the Mississippi river, the same altered iron formation occurs as in the central portion, and in it similar large ore areas; but here, instead of the merchantable ores, the non-merchantable silicious ores predominate, and in these ores are large quantities of a great variety of the altered material resulting from an incomplete process of disintegration and enrichment.

Therefore, instead of the clean-cut features of a standard Missabe ore body, we see here a small amount of merchantable ore underlaid or surrounded by every derivative of the "greenalite" formation, and in some instances masses so great that they form veritable rock beds, layers and islands in this silicious ore material. Thus we find here extensive deposits of taconite lying above, within and under the ore material. These layers of silicious material within the deposit are divided from each other by a rather large body or


East View of Plant Showing Building and Track System

zone of more or less clayey and sticky paint-rock material, which was originally a layer of slate occurring in the original deposit.

As a further complication, there was found in the drilling, right under the surface and on top of some of the large ore areas, an entirely different deposit of ore material. This was afterwards found to be a cretaceous deposit containing fossils of various kinds and an ore material generally, of high phosphorous content.

Rock Dumps and Track Arrangement Connecting Same With the Plant.

STRUCTURE.

After these ore areas had been explored and determined and it was thought that possibly the ores were suitable for concentration it became necessary to make a classification of the various materials encountered with a view to arriving at the physical structure of the deposits: (1) in order that mining methods could be worked out adapted to the sizes and conditions of the ore bodies; (2) in order that machinery suitable for handling these possible wash ores might be constructed or found.

On account of the fact that churn drilling had to be resorted to in exploring these ore deposits, which method of drilling destroys the physical structure of layers of ore material encountered, and since in addition to these results of drilling we had only a few shallow test-pits and shafts mainly on the Arcturus property to work from, it was at first very difficult to get at the structure; but this was finally worked out and I attach hereto a section showing substantially the structure of these Western Missabe Range ore deposits. The reader will note in the center of this section the large paint

West View of Washing Plant Showing Tail Track, Water Supply Line and Tank; Electric Sub-Station.

rock layer separating the masses of ore material into two layers or zones. Each of these zones is a separate member of the formation, divided by the paint rock layer referred to above, and in these zones occurs the silicious wash material, generally speaking, in layers; and where of a standard character, made up of large and small pieces and grains of high grade ore arranged in seams alternating with seams of fine sand. Interbedded in these standard wash ore areas, however, are layers of hard taconite and all the other gradations of material encountered, varying from hard taconite to

material so soft that it can be crushed in the hand, in fact derivative layers of the original material referred to above. Over it all lies a deposit of cretaceous ore material and over this again the overburden or surface material, consisting of clay, sand, gravel and boulders.

Mining Methods.

After the physical structure of these ore deposits was known it became apparent that the only way they could be attacked commercially was by the open-pit method. This method, after the overburden had been removed, would afford us (1) the opportunity to stockpile or otherwise dispose of the cretaceous material which had been found unsuitable for concentration or other present day methods of treatment; (2) it would enable us to have the exact conditions of the ore deposit before us at any stage of the work; (3) it would enable us to handle to the best advantage the large quantity of ore material which could be treated; (4) it would afford us opportunity to sort out the waste material varying in composition and structure and entirely unfit for concentration lying within the wash ore zone, from the material remaining for concentration within that same zone.

MAIN POINTS BEARING UPON THE COMMERCIAL UTILIZATION OF THE WESTERN MISSABE SILICIOUS DEPOSITS.

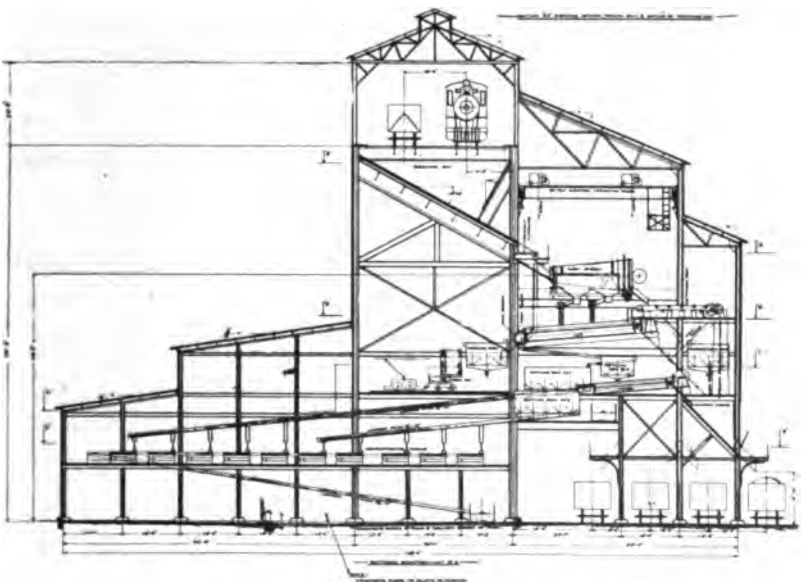
In approaching the problem of utilizing commercially the ore material from the vast deposits developed, we were confronted with the following conditions and facts:

First—A very heavy overburden as compared with the depth of the available ores or the ores directly and easily amenable to concentration.

Second—The occurrence very generally of a more or less thick layer of cretaceous material which was unmerchantable and further unfit for present methods of concentration, but which on the other hand, could not be wasted, as it carried considerable iron, and therefore must be removed and stockpiled at a considerable expense.

Third—Although there were in these deposits large tonnages of ore amenable to concentration, there was also found with them a large quantity of material entirely unfit for concentration, rough and hard in character and so large in size that it had to be sorted out either by hand or machinery, as the occasion would demand, at a considerable expense over and above the ordinary method of handling and disposing of such material.

Fourth—Furthermore, in this material, in and between the layers of standard wash ore, there occurred a vast quantity



Section AA Showing Screen, Picking Belt, and Bottom of Receiving Bin.

of material which was neither washable ore nor hard rock, in fact, consisting of every gradation possible between these extremes, and which could readily be sorted out. On account of its character and occurrence we were confronted not only with the necessity of handling this material and the expense connected therewith, but were forced to so construct our plant that a considerable portion of this could be advantageously dealt with in the mill operation. This particular

requirement for the mill meant a high degree of strength, durability and efficiency in the machines selected.

Fifth—Whereas most of the ore in the washable material was rather coarse, there was nevertheless quite a large amount of fine rich ore which on account of its exceeding fineness was not diserable from a furnace standpoint, but which nevertheless had to be saved as it already had borne a share of mining and transportation expenses, and for eco-

Tracks and Crude Ore Cars on Top of Receiving Bins.

nomical reasons alone could not be wasted when once delivered to the plant.

Sixth—The occurrence of the above mentioned paint rock. This material, having been derived from an original slate layer, was in its nature stickey and difficult to handle, when wet, contained a considerable amount of moisture, and was not amenable to concentration; but on the other hand its chemical composition was such that portions of it could be shipped di-

rect, while the remaining portion, which had to be removed to get at the underlying wash ores, could not be wasted and had to be stockpiled at some additional expense, because this material at some future day might become merchantable.

Seventh—Practical economic and lease conditions demanded a large tonnage, much greater than generally had been handled up to that time by mills elsewhere in the country.

Eighth—Large areas required, with extensive track systems

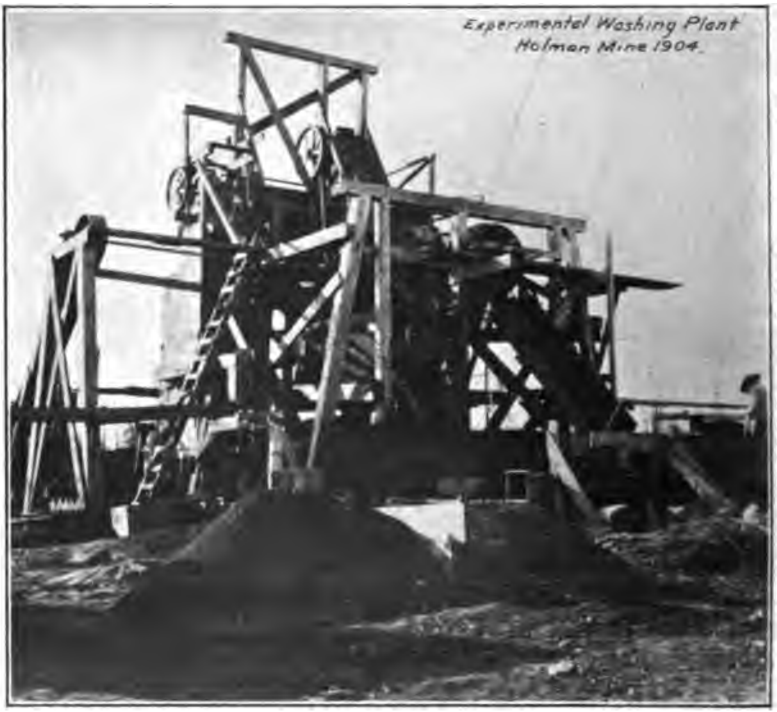
Interior View, Showing Front of Receiving Bins, Grizzlies and Revolving Screens.

to provide for the disposition of great quantities of overburden to be removed and for the stockpiling of low grade material not amenable to concentration.

Concentration of the Western Missabe Silicious Ores.

In 1901 and 1902 Mr. Walter Barrows, Jr., Mr. Chas. A. Purdon and associates, after obtaining certain exploration data from the Arcturus property, and additional information by drilling, desirous of ascertaining whether this ore was amenable to some sort of concentration, sent a car-load of ore

to Cedartown, Georgia, for treatment. The result seemed so satisfactory that they installed on the property at their expense a small concentrating plant consisting of conical screens and a set of McLanahan jigs. In 1903 and 1904 a small plant (see photo) of somewhat similar construction, but without jigs, was installed and operated at what is now known as the Holman mine, by Mr. Congdon and associates. While these two smaller plants clearly indicated that something could be



done at least with some portions of the vast ore bodies contained in the district, they also showed that these screens and jigs would not meet the requirements, first on account of the variety of material to be treated, and second on account of the large quantities that had to be handled. For this reason the officers of the Oliver Iron Mining Company appointed a committee to make a thorough study of the concentration problem

here presented, ascertain what was done elsewhere, and if possible find machinery which would meet the requirements.

After due consideration of all the facts and after an extensive trip over the western and southwestern portion of the United States the commission prepared its report recommending a scheme which seemed to them to offer a solution of the problem in hand.

As suggested by the committee an experimental plant was

decided on and erected in 1906 in the vicinity of the Canisteo deposits. (See photo.) In 1907 and 1908 experimental work was conducted in this plant with the machinery originally installed as well as with additional different concentrating machines which from time to time were tried out at the suggestion and request of manufacturers.

After a long, expensive and exhaustive investigation, and compilation and study of the results obtained, it was conclusively proved, 1st, that these ores could be economically and

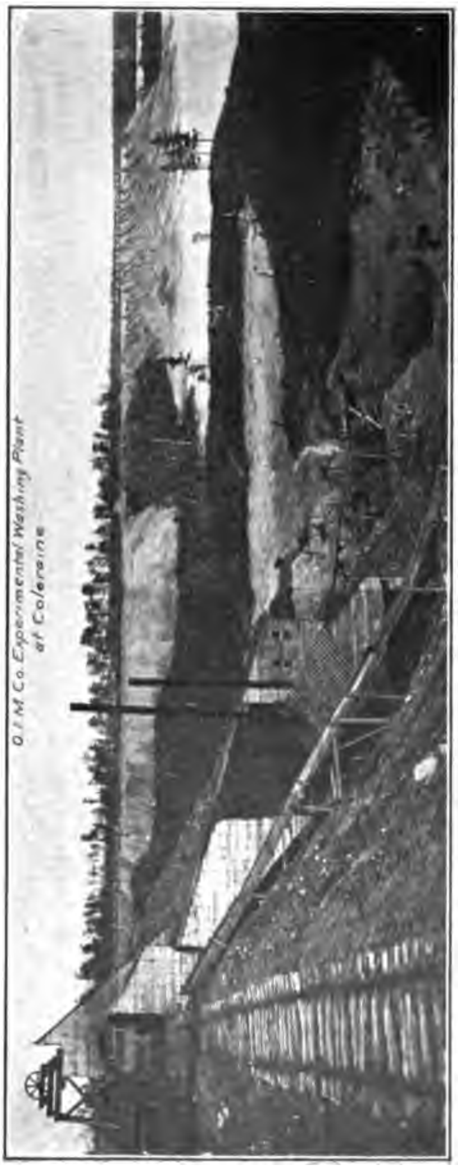
successfully treated and on a large scale made to render a merchantable product of a good desirable physical structure; 2nd, that machinery substantially such as suggested by the committee with some changes and improvements would successfully treat these ores.

Trout Lake Concentrating Plant.

(A) MAIN BUILDING AND SERVING TRACKS.

With these and other facts and data at hand the construction and erection of the present concentrating plant was undertaken. This work was commenced in April, 1909, and was complete with the machinery installed ready for use in 1910. Attached to the main building is a table house large enough to accommodate concentrating tables for five units and space for a small machine shop and supply store. For the handling of the railroad cars in the upper portion of the mill there is provided on the north side of the main structure a trestle approach 650 ft. long, and on the south or opposite side a tail track 300 ft. long. The latter is so constructed as to permit its being incorporated directly in a possible future extension of the plant. The building, viaduct approach and tail trestle, as well as the table house, are constructed of steel, the total amount used being 6,100 tons. The building is covered by corrugated steel sheeting over 2x6 in. wood sheeting fastened directly to the structural steel. The north end of the trestle approach is connected with the main road-beds forming the track system for delivery of the crude ore to the plant over an embankment of a maximum height of 110 feet containing over 2,000,000 cu. yds. of dirt. On the east side of the building is arranged a system of concentrate tracks connecting with ample storage yards for both loads and empties. The delivery tracks over the crude-ore bins are 90 feet above the tracks receiving the concentrates.

While not intended for winter operation, the mill building is equipped with a high pressure heating system, the steam for which is supplied by a small boiler plant located in the immediate vicinity of the mill.

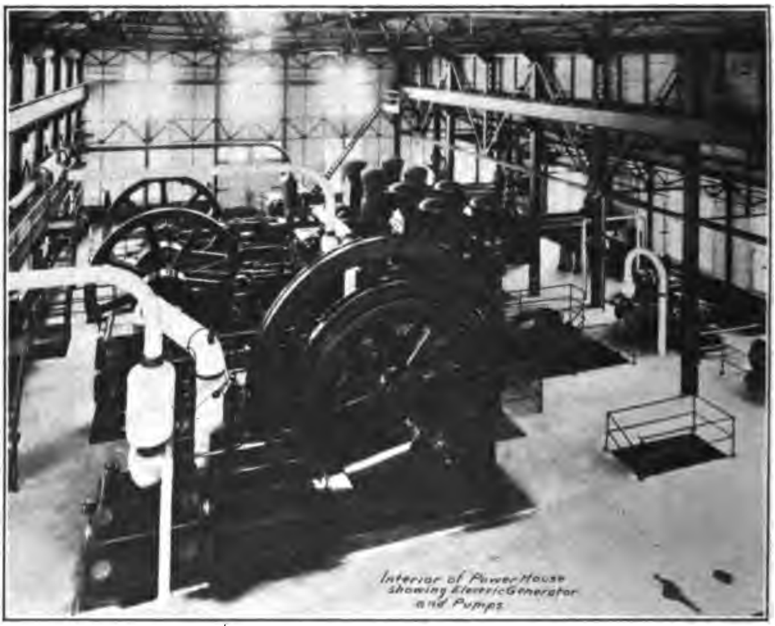


O. I. M. Co. Experimental Washing Plant at Coleraine

All inside wiring is placed in conduits. A traveling crane electrically operated over a track extending the entire length of the building provides for handling the heavy machinery.

(B) POWER PLANT AND TRANSMISSION.

The power plant of the mill is located on the shore of Trout Lake, 7,000 ft. distant from the main mill building. Clear water could not be obtained nearer the mill on account of the tailing discharge into the lake.



Boiler House—The power is generated in a battery of six, 72"x18', horizontal return tubular boilers housed in a building with a 120x53 ft. steel frame, brick nogged and covered with corrugated steel. Draught for these boilers is obtained through a chimney of hollow radial tile 150 ft. high.

Engine and Generator House—This building is of the same general construction as the boiler house, size 82 by 132 ft. In it is housed one 26x52x48 in. horizontal cross compound Reynolds Corliss engine, direct connected to a 1,250 kw. 3-

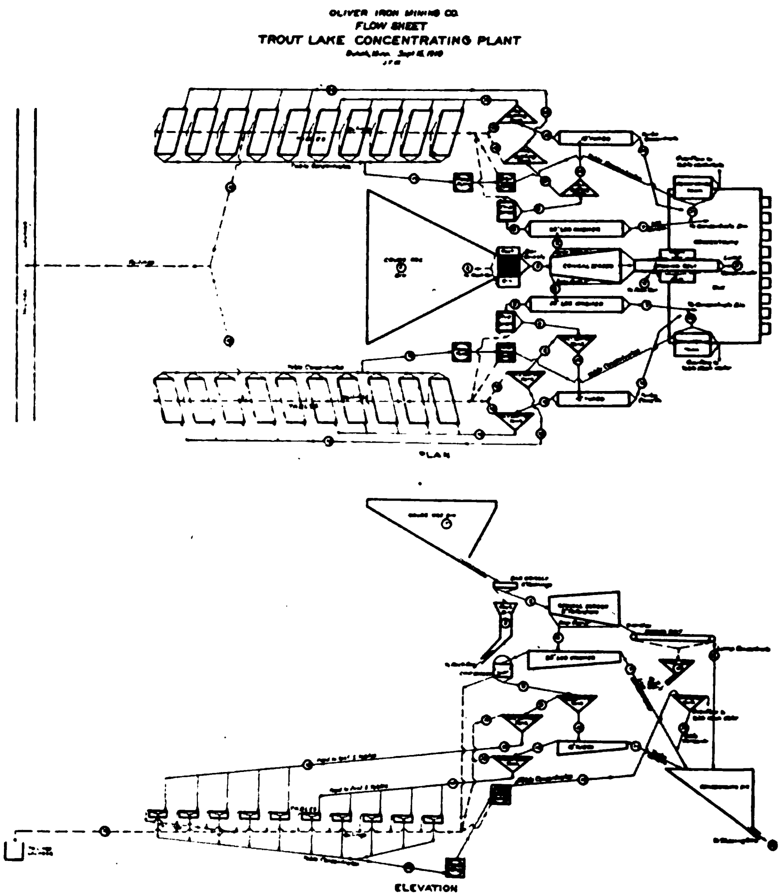
phase 60-cycle alternating current generator producing a current at 6,600 volts, equaling 1,675 horsepower.

In this building are also installed two 26x52x48 in. Prescott compound pumping engines, of the fly-wheel type, each with a 24-hour capacity of 10,000,000 gals., total lift being 240 ft. Each of these pumps is capable of furnishing the water necessary to operate the mill. As the five concentrating units contained in the mill described require individual consumption

of 1,300 gals. per min. per unit, the power requirement of each pump is about 400 horsepower.

The electric current generated is transmitted over surface lines to a transformer station located near the mill, where its pressure is stepped down to 440 volts—the working pressure required for the plant. Power transmission in the mill is so arranged that each working unit and the main group of machines in the units themselves are independently operated by commensurate motors. All buildings are electrically lighted.

Water Supply—Water is obtained from the lake through a 40-in., 400 ft. long, steel intake pipe and is conducted through a 30-in. lap-welded steel pipe to a 100,000 gal. cylindrical steel tank at the mill. The water pressure on the various floors of the mill varies from 20 to 75 pounds per square inch.



(c) CONCENTRATING MACHINERY AND APPLIANCES.

As the mill stands today the plant contains five independent units and appliances. Each individual unit is made up of two half units which are dependent on one another only in

bin and screening capacity. This arrangement was adopted to prevent delay in the entire mill and in each separate unit—should break-downs occur. Installment of individual units was also necessitated by lease conditions requiring that ore from each property be handled separately. All units are entirely similar in construction, but were installed at various times, the first and second units being erected in the spring of 1910, the third in the fall of the same year, the fourth

Lower End of Crude Ore Bin and Grizzly

and fifth completed at the beginning of the season 1911. Precaution was taken to eliminate from the mill construction all light and unreliable machinery such as link belts, chain elevators, conveyors and automatic feeding appliances.

Each individual unit is made up as follows: At the top of the mill and directly under the crude ore tracks, for each unit there is a receiving bin with a capacity of about 500 tons crude ore. At the discharge end of this receiving bin is a grizzly—steel rails spaced 12-in. centers—and also a hydraulic

nozzle connected to the water system. Under the grizzly is a rock pocket. The hydraulic nozzle is capable of discharging into the receiving bin at the direction of an operator, a heavy stream of water under a pressure of 33 pounds per square inch. The bin extension under the grizzly is through an apron directly connected with one conical, revolving screen or trommel having 2-in. perforations. Passing through the center and along the entire length of this trommel

Turbo.

is a spray pipe. The size of the trommel is: Length 20 ft., diameter at the small end 4 ft., at the larger end 8 ft.

Directly below the large end of the trommel is placed a conveyor belt 36 in. wide and 20 ft. long to take the over-size material from this screen. Directly below the trommel is constructed a bin or junction-box divided into two compartments into which falls the under-size material. On each side of this bin and below the same and at proper distances and elevations

are placed two log washers each taking one-half of the undersize material delivered into the junction box from the trommel. The size of these log washers is: Length 25 ft., width 6 ft. 8 in, depth 3 ft. They are placed at an incline of 1 in. to the foot, and are each provided with twin logs with chilled cast iron paddles. Their bottom is constructed so as to provide for three hutches covered with perforated steel plates through which a strong current of water under a pressure of

50 lbs. to the square inch is forced. The waste material coming over the overflow end of the log washers contains chips, waste and other material, and for this reason a chip screen has been placed directly behind each log washer. Directly under these log washers are placed three steel settling tanks, Nos. 1, 2 and 3, at different elevations. Located directly under No. 1 tank on each unit is placed one smaller log washer locally known as a "turbo." The size of these turbos is as follows: Length 18 ft., width 4 ft., depth 1½

ft. These turbos are of the same general construction as the larger log-washers, being provided with a rising water column forced under pressure through hutches and hutch-plates.

The tanks above referred to are "V" shaped. Tank No. 1 is 5 ft. in width by 8 ft. in length and 4½ ft. deep. Tanks Nos. 2 and 3 are 6 ft. in width, 16 ft. in length and 5½ ft. deep. All are provided with spigots for the discharge of the accumulated material.

Arcturus Experimental Washing Plant, Front View.

In the table house at some distance below these three steel tanks are located four batteries of five Overstrom tables, arranged in two parallel series. Each of the twenty concentrating tables is 14 ft. in length and 6 ft. wide along end lines, and is provided with riffles, which on some tables are constructed of wood and on others of rubber.

To convey the table concentrate from the table house, two 54-in. Frenier spiral sand pumps are installed in each one-

half unit. These pumps discharge into a de-watering tank located immediately above the bin into which is assembled all the concentrate from all machines constituting the unit. This de-watering tank is also of steel "V" shaped, top width 7 ft., length 12 ft., and depth 5½ ft.

The conveyor belt above referred to is known as the "picking belt." On each side of it is located a steel chute leading to what is known as a "rock pocket" made of steel. This discharges into cars below. These cars are hauled by an electric locomotive to a rock dump a short distance beyond the confines of the plant, over a track system overheading the main shipping tracks on the east side of the plant.

The concentrate receiving bin is large enough to accommodate the entire unit, built of wood and lined with steel plates, and has a capacity of about 90 tons. This receiving bin is provided with discharge lips through which this concentrate passes into railroad cars on the tracks below.

The following arrangement gives the power distribution for the unit: One 100 h.p. motor is used for driving the cone-shaped trommel, two log washers and two turbos. One 15 h.p. motor is used for driving the concentrating table and chip screen. One 20 h.p. motor drives the four Frenier pumps serving the unit.

The concentrating equipment in each unit thus includes:

One receiving bin.
One grizzly.
One conical screen.
One belt conveyor, or picking belt.
Two 25-ft. log washers.
Two 18-ft. log washers.
Six steel settling tanks.
Two table wash-water tanks.
Twenty Overstrom concentrating tables.
Four Frenier pumps.
Two steel de-watering tanks.
Two rock pockets.
One concentrate bin.

Process of Concentration.

At the mines the crude ore is loaded directly into hopper cars of an average capacity of 40 tons of this material. The cars are of pressed steel, of Sommers and Pressed Steel Car Company design. Train loads of these cars are hauled over the receiving tracks and over the viaduct approach to the top of the mill and there dumped directly into the receiving bins. In these receiving bins the ores are attacked by a

stream of water from the hydraulic nozzle above referred to and sluiced down through the opening in the lower end of the bin over the grizzly bars, which eliminates the larger pieces of taconite included in the shipment. This rock is raked from the top of the grizzly by hand into the rock pocket provided for each unit. The material passing through the grizzly is conducted over the connecting apron into the revolving trommel. The over-size material in this trommel advances through it and is in passage subjected to a thorough

rolling and rubbing process as well as a heavy spray of water from the spray-pipe arranged for this purpose. After being thus abraded and washed off, the content of this trommel passes on to the picking belt provided in front and is here hand sorted. The rock material is thrown into the chutes leading to the rock pocket whence it is loaded into cars and by an electric locomotive hauled to the rock dump. The coarse material remaining on the picking belt falls directly into a steel chute which conveys it to the concentrate bin immediately below. The material obtained is known as belt product and consists of lump ore concentrate of sizes larger than 2 in.

The material passing through the conical screen or trommel falls directly into the underlying junction-box, half of the material going to each of the two log washers provided on either side of this junction-box. In these log washers the material is subjected to a combined stirring and abrasive action produced by the paddles of the twin logs revolving therein, in water which enters the log washer under pressure through the three bottom hutches. This introduction of water under pressure into the bottom of the log washer is a decided improvement over earlier constructed log washers, and is an important provision in that it prevents dead material from lying at the bottom of the box, assists in the thorough stirring and washing of all the material passing through the machine, and gives life and activity to the entire operation. The action of the log washer in this process is that of a large, efficient, ever-ready classifier-concentrator and disintegrator. By stirring effect of the paddles, the friction between them and the pieces with which they come in contact, as well as between the pieces themselves in this ever-moving mass under strong water action, all the more or less disintegrated pieces are broken up into their component parts—grains of sand and pieces and particles of ore.

In the operation the heavy flow of water introduced into the machine, both with the material itself as well as from

the bottom, carries the sand towards and over the tail-board at the lower end of the machine. The heavy material, on the other hand, consisting largely of iron ore varying in size from 2 in. to grains, is forced by the action of the paddled twin logs towards the raised or upper end and there discharged as log product into the concentrate-receiving bin.

The overflow from the log washer is then passed through the chip screen for the purpose of removing pieces of wood,

Track System
Serving Rock Pockets

waste and other foreign substances. From the chip screen the material is led into what is known as the first set of settling tanks, one on each side of the unit. The heavier material is allowed to settle and the spigot product is fed to the two turbos below.

As stated before the "turbo" is similar in construction to the large washer, but smaller. The operation is also similar.

The overflow from the settling tanks is passed into a sec-

ond pair of tanks. The overflow from these is carried out of the mill, and the spigot product is conveyed into the table room and there distributed over two sets of five Overstrom tables, each set serving one tank.

The concentrate obtained in the upper end of the turbos is fed directly into the concentrate receiving bin of the unit. The overflow from the turbos is passed into a third pair of settling tanks. The overflow from these is passed out of the mill. The spigot product is carried into the table house and there dealt with in a manner similar to that in which the spigot product from the second pair is handled.

The concentrate from the twenty tables serving each unit is conveyed through the four Frenier pumps serving the unit into the de-watering tank, the spigot product of which falls directly into the concentrate receiving bin beneath.

All tailings from the settling tanks and tables are discharged into Trout Lake below the mill through a 4-ft. wood bottom concrete flume.

Safety Devices.

The great amount of thought which has been put into safety devices, and the minute detail into which those in charge have gone, make impossible complete description in a paper of this kind. Therefore only the more prominent features will be described, and perhaps the most simple course to follow will be the one most commonly used, that is, the route of the ore.

The first application of a safety feature is in preventing the crude ore from falling through the approach trestle from the cars to the ground. The great height of this trestle would make an injury from this source very serious. This is prevented by a decking which also eliminates danger of fire from the sparks of passing locomotives. A structural steel hand-railing extends the entire length of the trestle on both sides and is supplemented by a toe-board at its bottom.

Within the building, at the receiving bins, the most apparent features are, first, the peculiar arrangement of rail-

ings and walks which compels the workman unconsciously to guard himself from passing trains, and second, the covered stairways and landings by which the sluicer helpers are enabled to work beneath the tracks with safety and freedom.

Within the mill proper, at a point where the ore is washed from the bins into the revolving conical screens, are placed large heavy hinged gate and a stationary wall which serves as a sort of breastwork in front of the sluicer. The stationary walls afford the worker safety from sudden slides of ore while sluicing, and the hinged door protects him from the same danger when ore is being dumped into the bin.

At the picking belts are provided hoppers located con-

Electric Sub-Station

veniently near both the belt and the men. While these are built up high enough to greatly facilitate removing the waste rock from the belt, their primary purpose is to prevent the men from falling into the pockets beneath. The chutes from these pockets which receive the waste rock were provided with the customary quarter-pan or pocket stops, but as these did not prevent small pieces from rolling out beneath them down on to the heads of passers-by, it was necessary to provide an additional means to prevent this. Such a device consisted of a special counterbalance gate or dam made of steel plate. The peculiar location of the stop itself and the point from which it was to be operated made this a difficult problem. The

electric tram cars which carry the rock from these chutes to the dumps are provided with automatic gongs which ring when the cars are in motion and warn the workmen of their approach.

The next point of possible danger in the course of the ore is in the discharge from the log washers. The problem here was somewhat difficult, for in order to inspect properly the concentrated product the workmen had to stand between large revolving gears on one side, and the moving blades of the washers on the other. However, the difficulty was solved by means of gear housing and platforms in such a manner as

Water Supply Line

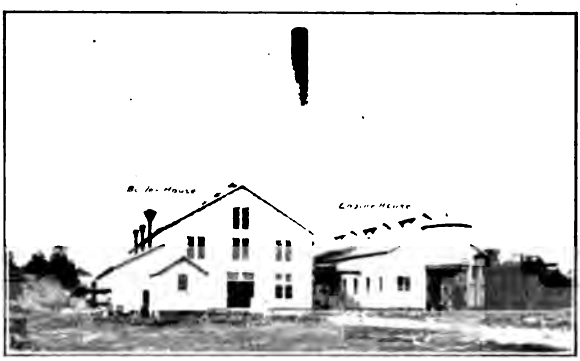
to make this point very accessible and at the same time remove both danger and fear of injury.

On the table floor, the driving-head gear of the machines presented the chief source of danger. To obviate this, frames built of pipe and covered with removable steel plates were placed around the driving mechanism. This secured safety and accessibility. Shifting levers for the belts, so designed as to be simple and free from projecting parts, were attached to these frames.

In the basement the only point which was considered dangerous, and this on account of darkness rather than location, was the driving mechanism of the Frenier pumps. The

installation of steel geared housings, wooden troughs for belts and a generous lighting system, did away with all danger at this point.

There are many miscellaneous devices which though not so intimately connected with the operation of the mill, are none the less necessary. The most important of these are the coverings of every gear, belt, pulley, and moving part throughout the mill, and the safety collars on all shafting. Enameled iron signs warning operators are placed at every conceivable point of danger. Signal bells are sounded when starting all mill machinery, so that every working man may protect himself if in danger or invisible to the operator. Per-



Power Plant

manent stair-like platforms were constructed beneath the receiving bins, to enable workmen safely to remove the bolts that hold the wearing plates when repairing them. Stairways were everywhere provided rather than ladders, and all of them were covered at the backs, thereby preventing material from falling or being kicked through them on to the head of persons beneath. But perhaps the greatest of all provisions for the protection of the working man in his routine duty about the mill is the most carefully planned and permanently constructed system of railed walks. These lead everywhere. They are rigid and strong to the last degree. Their railings are of steel pipe, their stringers and joists are of steel beams.

Their treads are of the heaviest matched flooring, and their sides are protected by the ever-efficient, though obscure, toe-board. Records show that in this item alone, 32,300 lineal ft. of 1¼ in. standard pipe with the necessary fittings, and 12,450 lineal ft. of 2x8 in. surface pine boards have been used. Not the least of the factors which makes this provisione one of the most worthy of the safety device is the sense of security, which the workmanship apparent in it engenders.

In conclusion, it must not be supposed that the apparent completion of these safety devices has tended to eliminate interest in safety measures. On the contrary the interest is even greater, because it has been shown that the effort, money and vigilance expended in this direction produces the most gratifying results.

PRODUCTION.

	Tons.
Plant produced in 1910 with 2 units in operation....	610 000
Plant produced in 1911 with 5 units in operation....	1,978,000
Plant produced in 1912 with 5 units in operation...	2,555,000
The construction of the plant including power installation, water supply and necessary track arrangements, involved an expenditure of approximately	$1,500,000

The total amount of concentrate produced by the various machines in the unit depends largely on the character of the crude ore treated. The following table will, however, give a general idea thereof:

	Per Cent.	
Belt product	3 to 35	Depending on character of crude ore.
Two logs product...........	60 to 85	
Two turbos product..........	2.5 to 10	
Twenty tables product.......	1.5 to 6.5	

Concerning the size of the product obtained, it may be stated that the belt product is all larger than 20 mesh. Of the log product 90 per cent. is coarser than 40 mesh and 4 per cent. finer than 100 mesh. Of the turbo product 15 per cent. is coarser than 40 mesh and 32 per cent. finer than 100 mesh,

Of the total table product 85 per cent. is finer than 100 mesh and 50 per cent. is finer than 200 mesh.

These figures will indicate the care which has been taken in the processes, in the construction of the plant and of the various machines therein, to effect a saving commensurate with good practice, economy and furnace requirements.

The above is a general and practical statement devoid of complicated calculations and demonstrations, entering into the solution of the problems connected with the handling of the wash ores on the Western Missabe Range, involving the construction of, and the processes devised for, the Coleraine Washing Plant.

In conclusion I wish to state that while it would be desirable and interesting from a scientific and economical standpoint in a subject of this nature, to enter into, for instance, the specific performance of each machine, the possibility of improving and of simplifying both method and machinery, to consider the question of recovery and the ratio of concentration, and finally to demonstrate the extent to which this plant as a unit has served its purpose as a medium through which this non-merchantable ore is made merchantable, it is impossible to touch upon these subjects within the scope of this paper, as time and conditions will not permit it.

The items referred to above may be proper subjects for another paper on a future occasion.

Lastly, while this plant today does its work as well and even better than expected, at some future day no doubt it will be changed and improved, or others will be built to take its place to meet conditions not here presented, but fully known from investigations made, which conditions it is neither practicable nor advisable to approach nearer at the present time.

THE APPLICATION OF MINING MACHINES TO UNDERGROUND MINING ON THE MESABI RANGE.

BY H. E. MARTIN AND W. J. KAISER.

The application of machines to underground mining on the Mesabi Range is a radical departure from the methods in use at the present time, and while it is difficult to foretell the ultimate results, their use cannot but be beneficial both to the miner and the mining companies.

Since mining was started on the Mesabi Range some twenty odd years ago, improvements and changes have been made in practically every method and device except those used in the actual mining of underground ore. During the past few years open pit mining has grown from a comparative infant to its present huge proportions. Heavier steam shovels, larger engines and standard equipment have been adopted, as well as various changes in methods employed. In our underground mines, the most efficient machinery has been installed for handling the ore once it has left the miners hands. The miners, however, still drill by hand, muck their own dirt and otherwise mine as they have done since the start. The number of miners on this range has not grown in proportion to the amount of development, and in consequence the production from underground mines has not been as large as it should be. How to increase the production, using the limited number of miners available, is then the question of vital interest. Could power machines be successfully used, it would necessarily mean a division of labor into two classes, miners and muckers, and the output per miner would be largely increased. The common laborers, becoming more proficient, would eventually graduate into the miners class, thus increas-

ing their number. With these ideas in view, it was decided to experiment with machines on the soft ores of this range.

As used at the Harold Mine, of the Hibbing District, the machines consist of an ordinary Sullivan air-pick or coal puncher, and a Jeffries air-auger. The pick machine is the largest type manufactured by the Sullivan Machinery Company having a depth of undercut of five and one-half feet.

Sullivan 700 lb. Pick Machine in a four-foot vein of coal, Pennsylvania. Runner sits on board, guiding machine by handles and foot-clog.

The bore of cylinder is 5⅛ inches, pressure required 80 pounds, and total weight 825 pounds. To understand thoroughly the application of these machines to our mining methods, it may be well to mention first the several operations incident to taking out a set of ground by ordinary means. The miners first drill a round of holes in the breast, each hole approximately five feet in depth and varying in number from three to five, depending upon the height of post, character of ground and whether drifting into the solid or along side of

caved ground. The upper holes are usually fired first and the bottom holes after the top dirt is mucked out. The amount of dynamite used depends upon the conditions mentioned above and varies from 15 to 30 sticks, each stick being about ½ pound. After the upper holes are fired the miners secure the back by poling from the last set of timber into the breast. The ore broken in this blast is then loaded and trammed, and the bottom holes are fired. After all the ore is mucked out, the miners trim the breast, back and sides and the set is ready for timber. Under ordinary conditions the amount of time spent in these several operations is approximately as follows:

Drilling, 17 per cent; blasting, 4 per cent; clearing of smoke, 3 per cent; tramming, 7 per cent; trimming, 9 per cent; timbering, 20 per cent, and mucking, 40 per cent.

The number of men required for one machine crew, is two machine men, three miners and six muckers. This ratio was experimentally determined and is of the most importance to the efficient working of the machines, in that there should be no delay of miners, muckers or machine men waiting upon each other. The minimum number of working places or rooms required to take care of one machine has been found to be five, though a larger number will insure no delays and make for higher efficiency.

The actual taking out of a set of ground with the aid of the machines is as follows:

The set is first under-cut with the puncher to a depth of five feet, the cut extending from the solid rib to within six inches or so of the opposite side, thus leaving a small pillar six inches wide and the full length of the set. The purpose of this small pillar being to support the ground against premature caving. Two holes are then drilled with the air-auger, about one foot from the solid rib and spaced about two and six feet respectively from the back. In case the slice was driven into the solid four holes would be necessary, two on each side. Two short holes are drilled in the small pillar supporting the

set by the miners. Boards are now placed in the cut and under the set to be broken out, a small amount of ore picked down upon them to hold them in place, and the holes are loaded and fired. Being able to place boards beneath the set before it is broken, is an advantage rather hard to estimate but of considerable moment to those using the shovels, giving them as it does a smooth surface from which to shovel. The miners now secure the back by poling and the room is ready for the muckers. After the ore is mucked out, the

Sullivan 825 lb. Pick Machine in a Southern Illinois mine, 8-foot coal. This shows the undercut completed at left, and a fresh "board" started to the right.

miners square up the set, place the timber and another cycle of operations is started.

The average time for under-cutting one set of ground excluding delays, has been 59 minutes, for moving from place to place and setting machine, 26 minutes. To drill one foot of ground with the air-auger has averaged 2.8 minutes, time setting up 1.4 minutes per foot. These results can and no doubt will be considerably lessened, as the machine men become more proficient.

The advantages which can be claimed for the machine, aside from any possible reduction in the cost of producing the ore, are employment of one-half common labor, using approximately one-half the amount of dynamite, less liability of posts being blasted out and consequent caving of rooms, and always having a smooth surface to shovel from. To the successful working of the machines, several conditions are necessary. The rooms served by the machine must be easy of access from one to another, their height should not be less than seven or eight feet and no bottom stoping should be necessary. In other words they can be applied to ordinary slicing and square-setting.

The results obtained so far have not been as satisfactory as could be wished, primarily due to the labor situation, muckers not being obtainable in sufficient number to keep the machine and miners busy at all times. At the start many delays were occasioned by not having a sufficient number of places opened up for the machine. However, during the first five weeks of work, the average number of tons per man per day was twelve, an amount considerably above the average for most places in our underground mines. Taking these points into consideration, it can be conservatively said, that it is not a question of what the machines can or will do but merely one of organization and hence their future on the Mesabi Range seems assured.

OPENING THE LEONIDAS MINE AT EVELETH, MINNESOTA.

BY H. E. LOYE, EVELETH, MINN.*

At the Leonidas mine of the Oliver Iron Mining Company, at Eveleth, Minnesota, two ore bodies were found separated by rock 250 ft. in thickness. The upper body averaging 49

Leonidas Mine, Eveleth, Minn.

ft. in thickness, will be mined in greater part by the open pit method, the lower body averaging 76 ft. in thickness, by the underground method.

On account of the long period of time required to mine this lower deposit, it was desirable to have the shaft and stations as permanent as possible, and also as shaft stations are the parts most subject to fire, and as in this case there will

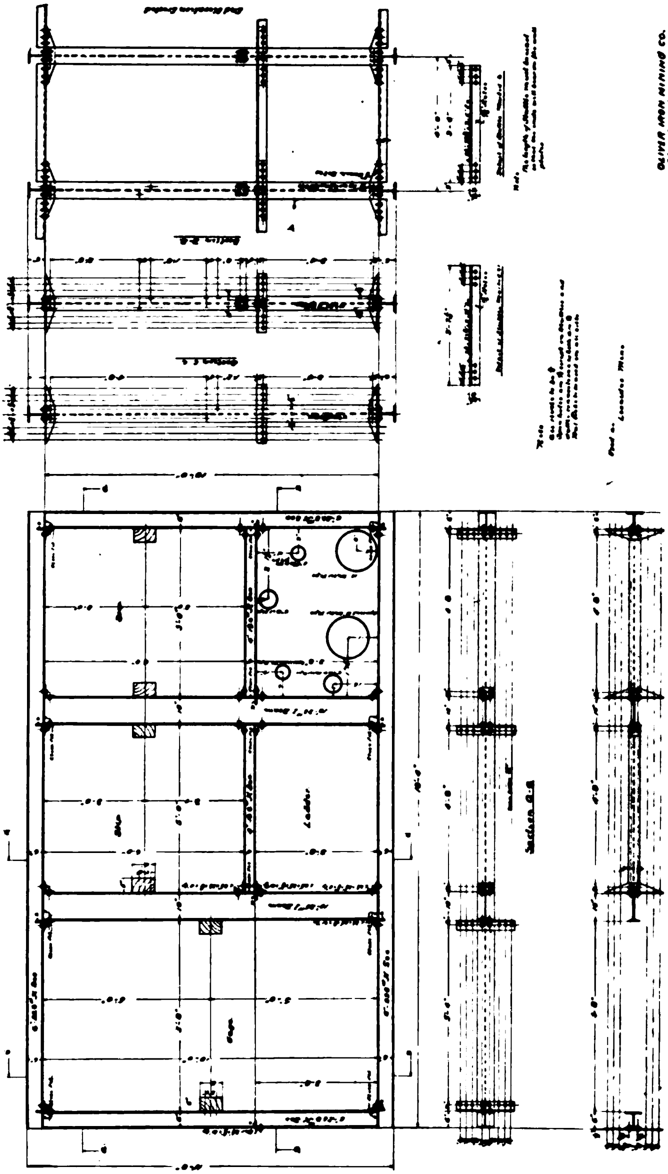
*Chief Engineer, Oliver Iron Mining Co., Adams District.

be only one outlet for a number of years, it was very important to have the shaft and stations as nearly fireproof as possible. With this in view, it was decided to use only steel and concrete in the construction; steel sets made by the American Bridge Co., backed by reinforced concrete slabs made with Universal Portland cement.

The shaft, which is 10 ft. by 17 ft. 4 in. in the clear, contains five compartments; two skip compartments 6 ft. by 5 ft., pipe and ladder compartments each 3 ft. 8 in. by 5 ft. and a cage compartment 10 ft. by 5 ft. 8 in., as shown in Plate 1. The wall and end plates are made of 6-in. 23.8-lb. H sections, the main dividers of 10-in. 25-lb. I-beams, the smaller dividers of 4-in. 13.6-lb. H sections and the studdles of 3½ in. by 3 in. by ⅜-in. angle irons. Sets were placed 4 ft. center to center and 2-in. planking used for temporary lathing, to be replaced later by reinforced concrete slabs, the planking resting in the hollow of the H section and being flush on the inside of the shaft so as to prevent lodgment of material. In sinking, the sets were kept from 12 to 16 ft. above the bottom of the shaft to avoid any breakage by blasting. The bearing pieces used were 12-in. 31.5-lb. I-beams, 19 ft. 6 in. long, 4 in a set, placed under the end plates and dividers with their ends concreted into the hitches, as shown on Plate 2. Five sets of these bearers were put in as follows: At collar, at 113 ft., at 213 ft., at 313 ft. and at 438 ft.

In sinking the shaft, 72 ft. of surface or glacial drift was passed through, the remainder of the shaft being sunk through taconite. Water was encountered at a depth of 30 ft. and the flow became so heavy at a depth of 268 ft. that a temporary pump station was cut, 8 ft. by 16 ft. by 41 ft. in the clear with a sump 10 ft. by 12 ft. by 7 ft. Two 9 and 18 by 8 by 18-in. Prescott compound duplex pumps and a 14 by 9 by 18 in. Prescott duplex pump were installed in this pump-house with four 14 by 8 by 12 in. Prescott sinking pumps shambling the water to them. At this time 1,500 gallons per minute were being handled. The column and steam pipes were carried

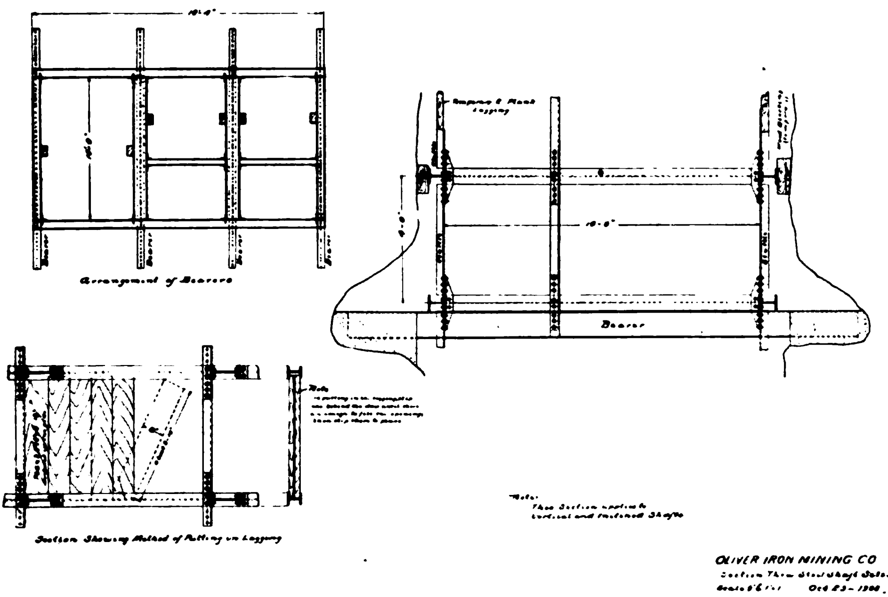
PLATE I.



Steel Shaft Sets and Stuttles for Five Compartment Shaft

down the shaft according to the permanent lay-out as shown in Plate 1, so that when the shaft was completed it was only necessary to carry the piping down from the 348 foot pump station. By the time the shaft was 356 ft. in depth, 2,400 gallons per minute were being handled requiring six sinking pumps in the shaft, one throwing to surface, and as the flow was increasing, it was necessary to put in another temporary pump station, at a depth of 348 ft. This is 10 ft. by 18 ft. by 61 ft. in the clear, with a sump 14 ft. by 16 ft. by 6 ft. In

PLATE 2



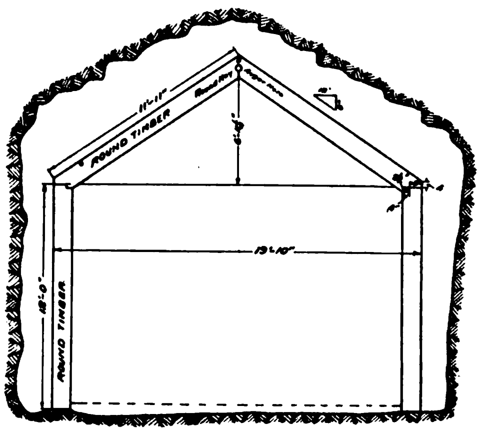
Section Through Steel Shaft Sets.

this station was installed one 12 and 24 by 12 by 24 in. and one 12 and 24 by 10½ by 24 in. Prescott compound duplex pumps and the two 9 and 18 by 8 by 18 in. Prescott compounds were moved down from the upper station. This equipment, using six sinking pumps, sufficed to complete the shaft although the flow ran up to 3,500 gallons per minute before the shaft was finished. When the permanent pump station was being cut the flow ran up as high as 4,000 gallons per minute and to

handle this required the addition of a 14 by 9 by 18 in. Cameron pump which with one of the sinking pumps was put in on the entry level and both discharged to surface, the other five sinkers shambling to the 348 foot pump-house.

The sinking of the shaft was greatly impeded by the flow of water, the miners working in from 12 to 24 in. of water

PLATE 3.



TEMPORARY TIMBERING.

LEONIDAS PUMP ROOM.

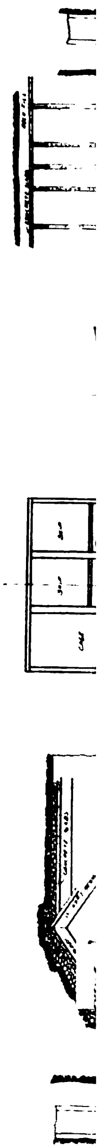
437 FT. LEVEL No. 1 SHAFT.

SCALE $\frac{1}{4}$" = 1'. SEPT 24 – 1913.

all the time. The great number of pumps in the shaft took up much room and made the shaft exceedingly warm. This shaft drained the Adams and Spruce ore bodies, leaving them dry by the time the shaft was 300 ft. in depth. In sinking from this point to the bottom, if one of the pumps broke down, it was necessary to stop work to enable the other pumps to handle the flow, and this caused many delays.

After completing the shaft to a depth of 448 ft., the entry

to the permanent pump station was started at a d ft. The rock-work in the entry and pump-house w two stopes, the upper running from 5 ft. in hei side to 13 ft. in the center, was kept 10 to 12 f the lower which was 8 ft. in height, the opening wide by 21 ft. high in the center, as shown on Pl entry is 32 ft. long and the pump-house openin As the steel for the sets could not be delivered in porary wood sets, as shown in Plate 3, were us them between where the steel sets would come ar outside line of the wood posts 1 in. in the clear o line of the steel sets. This facilitated the work o the hold-down bolts and small piers for the stee the erection of the steel work. When the rock-w main pump-house was completed, the steel sets w as shown in Plate 4, working from each end towa ter and then through the entry to the shaft, a easy way of completing the rock-fill behind the co The start was made by removing two wood sets a and putting in three steel sets, the first two being c Then the concrete slabs, as shown in Plate 5, whic ously been dipped in hot tar and dried on surfac in place in neat cement behind the steel and as ea placed, it was back-filled with broken rock tamp slabs were stepped up three to a set so that there slabs in the center of the breast set when the th steel and slabs were ready to proceed further wit The steel gang then removed one wooden set at placing it with a steel set, the slab work being slabs all around for each steel set placed. This left the back open for quite a distance but if the b any weakness props were put in either from the from the floor. Before the steel and concrete we was almost impossible to see from the the pump house on account of ater from the back but after these oom was tically dry.



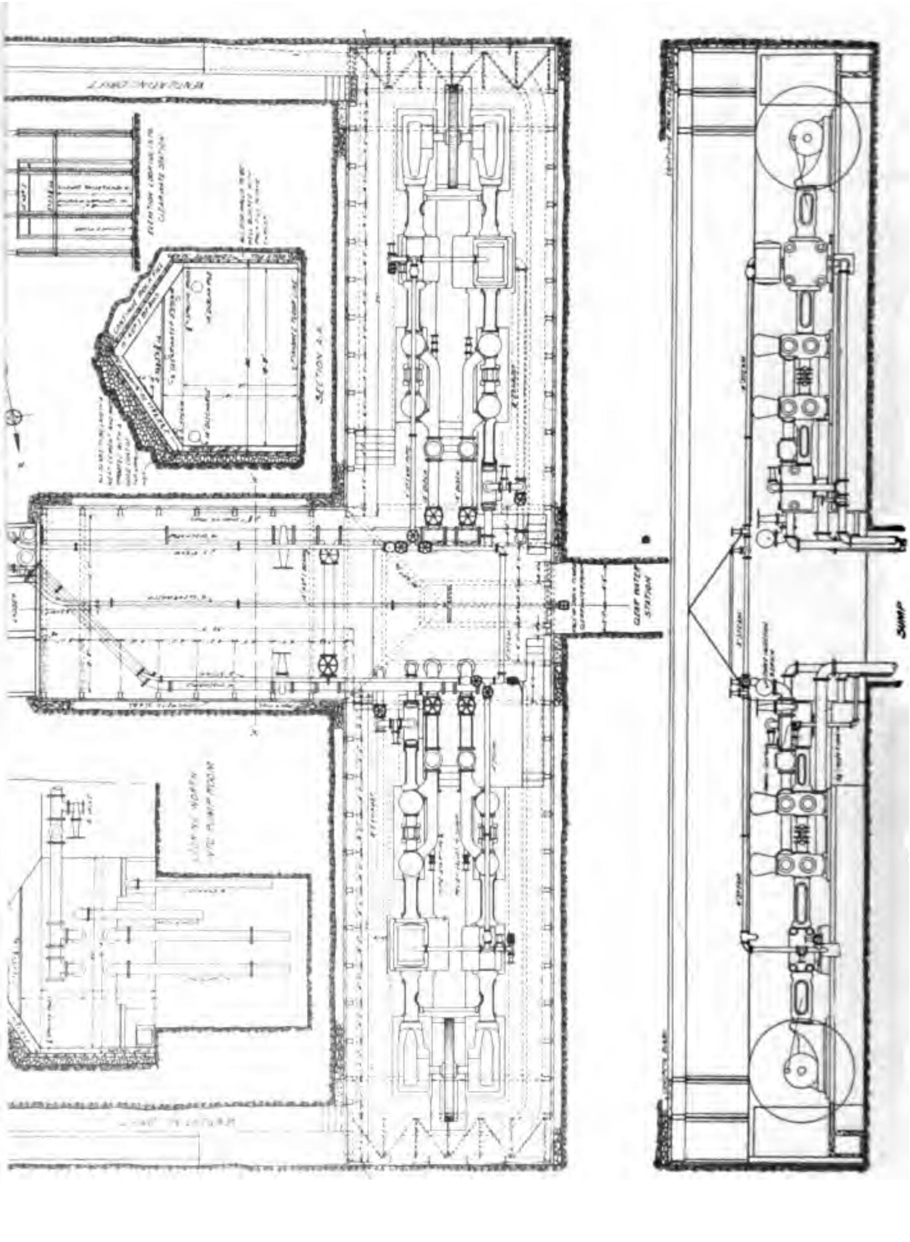
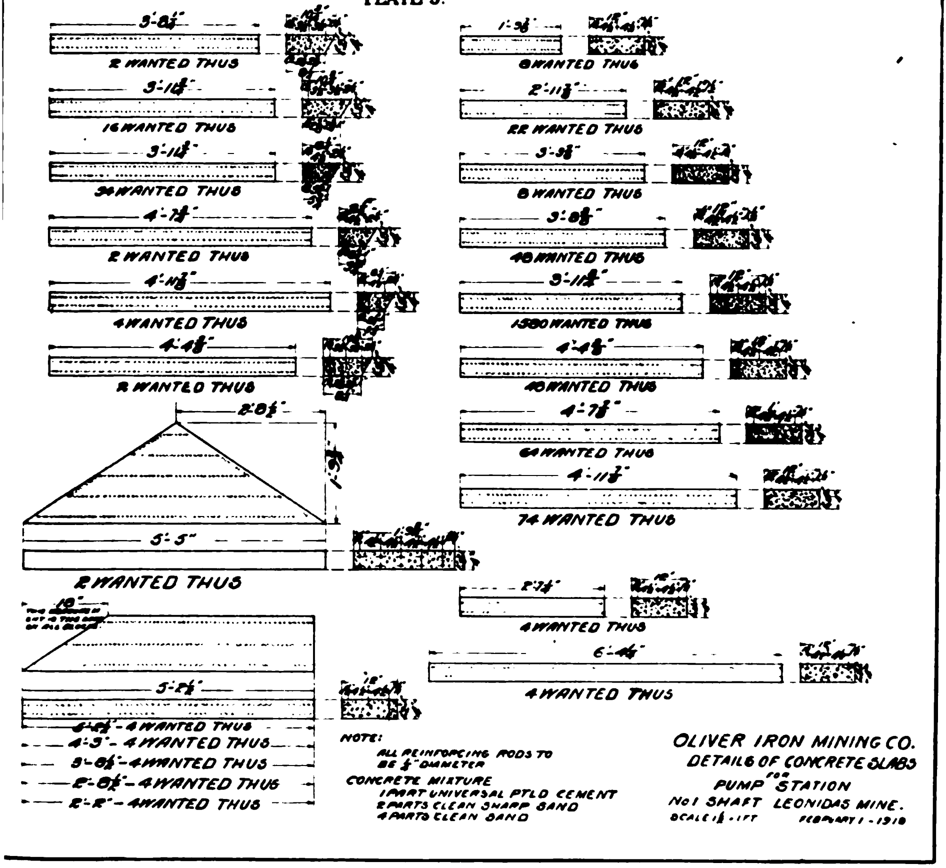


Plate 4. Construction and Arrangement of Pump Station, 437 ft. Level. No. 1 Shaft

To keep down the water pressure behind these walls short pieces of one inch pipe were placed under the slabs just below the floor level and these were connected to a pipe under the concrete floor leading to the sump. Pipes were also laid under the floor from the sump to each fly wheel pit so as to

PLATE 5.



be able to drain the pits, but valves were placed on these pipes and are kept closed so that in case of water rising up in the station it will not back up into the pits. On the top of the concrete slabs in the back, tar paper was used to shed the water until the cement could set, the back-filling being

placed in on top of the paper. Although in some places holes opened up in the back as high as 10 ft. above the sets, still nothing but rock was used for back-filling. When the station had dried up, the slabs were given two coats of white cold water paint and the steel two coats of turpentine asphaltum.

As soon as the steel sets had been placed in the clear of the pump foundations, the templets for these were placed and work started. These foundations were finished and had set suffi-

Plate 6. Engine End of South Pump.

ciently before the slab work was completed so that the pumps could be installed at once on the completion of the pump-house supportings.

The pumping engines are two 16 and 32 by 8 by 36 in. Prescott corliss cross compound condensing, Missabe type, crank and fly wheel, with horizontal jet condenser with a normal capacity of 1,500 gallons per minute and a maximum capacity of 2,200 gallons per minute against a head of 450

ft. Plate 6 shows the engine end of one of these pumps. This type of pump was selected on account of its economical operation, its guaranteed duty being 135,000,000 ft. pounds of delivered work per 1,000 pounds of dry steam consumed by the engine, when furnished with steam at 125 pounds gauge pressure and with a vaccuum of 26 in. of mercury. Each engine is supplied by a 5-in. steam line and discharges into an independent 14-in. column pipe. The steam pipes and

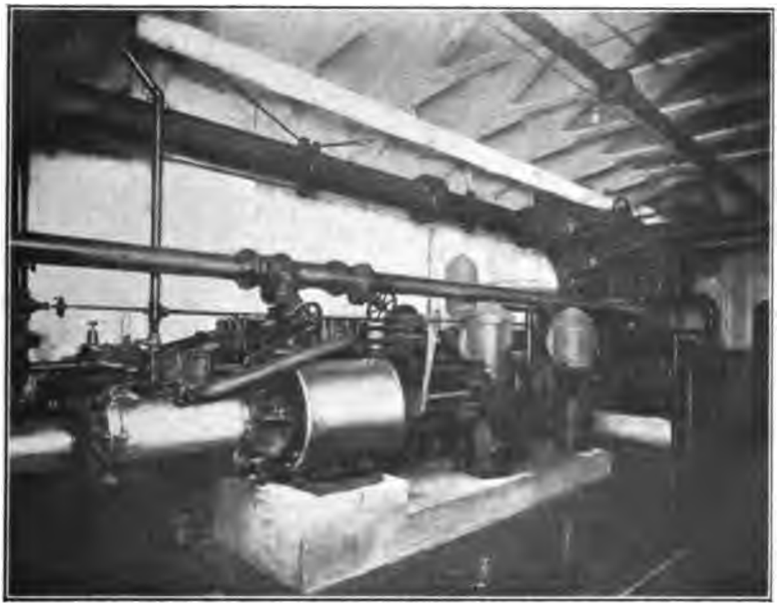


Plate 7. Emergency Pump in Entry Drift.

discharge pipes are cross connected in the entry and provided with valves so that either engine can take steam from either steam pipe and either pump discharge into either column pipe. This arrangement, as shown on Plate 4, prevents flooding of the mine due to one pump and the steam or discharge pipe of the other pump being out of commission at the same time. An auxiliary pump was installed in the entry drift for use in case of emergency as there is always the possibility of something going wrong with a new installation. This is a 12 and

Plate 8. Water End of North Pump and Entry Drift

24 by 10½ by 24 in. Prescott cross compound capable of pumping 1,200 gallons per minute against a 450 ft. head and is shown in Plate 7. A trench just under the floor of the entry connects the shaft and the sump so that the water in the shaft can flow into the sump without running over the entry floor. Plate 8 shows the water end of North pump and the entry drift from shaft.

A drift 50 ft. in length was driven to the west directly opposite the entry and at the breast a sump was put down 6 ft. by 6 ft. by 20 ft. deep. The drift is now practically

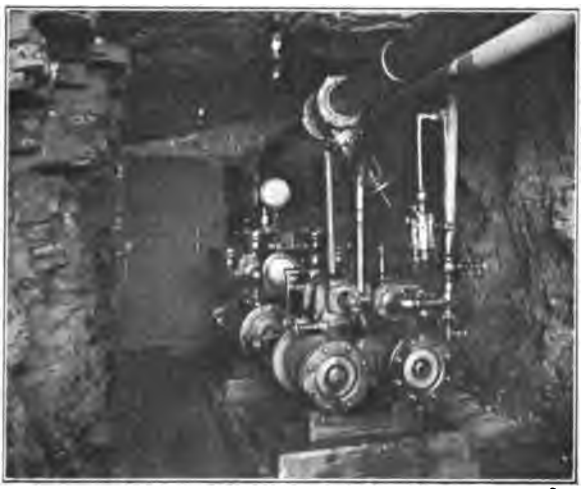


Plate 9. Clear Water Drift and Pump

dry, as shown by Plate 9, but there is an excellent flow of pure water from the breast, as shown in Plate 10, which was taken from the doorway in the wire partition shown in Plate 9. In this drift was installed the pump for supplying clean water for domestic and drinking purposes. This is an Epping-Carpenter pot-form pump 10 by 6 by 12 in. capable of pumping 350 gallons per minute against a 500 ft. head. The end of the drift has a heavy wire netting partition across it so that no one can get near the supply of water.

The ventilating drifts were driven in rock on an incline of

50 degrees, from each end of the pump station up to the main tramming level 30 ft. above. These drifts required no supports. Iron stairways with railings were placed in them affording a good passage-way between level and station. The water from the level above is conducted along the drifts from the breasts in box launders covered over for walk-ways, then down these ventilating drifts in 12-in. pipes into concrete launders below, the launders emptying into the main sump. Board partitions are placed in the box launders and screens

Plate 10. Breast of Clear Water Drift

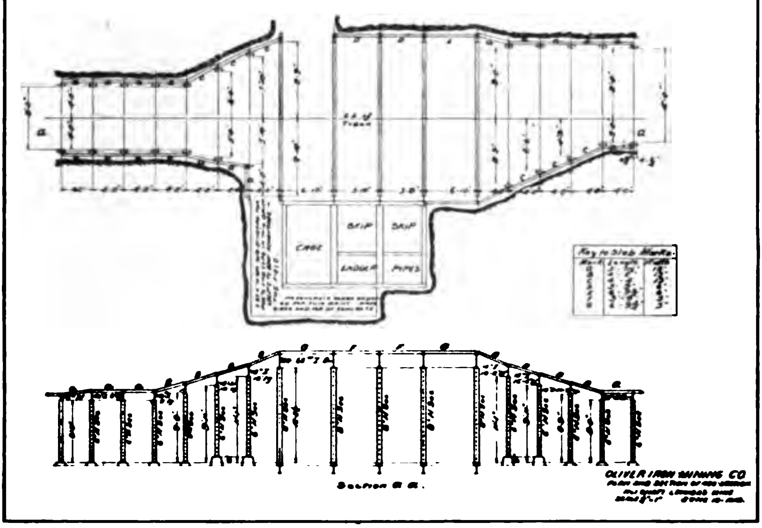
over the tops of the pipes to keep the mud, rocks and sticks out of the sump.

After completing the pump station, the main level station was started at a depth of 405 ft. below the collar or 33 ft. above the pump station. The level station is 19 ft. 6 in. by 47 ft. by 12 ft. high, in the clear, and has steel sets with concrete slabs for lagging on sides and back. On account of the ladderway being on the other side of the shaft from the station, a passageway around the shaft was made using steel sets and concrete slabs, while the temporary wooden laths in the shaft at the station were replaced by steel plates. Plate

11 shows the station lay-out, and Plate 12 shows a reproduction of a picture of the station.

The main drifts leading north and south from the main station and then turning to the east a short distance in, have steel sets and concrete slab lagging for some distance from the shaft. The one leading north has sets 8 ft. by 8 ft. in the clear, made from 6-in. 23.8-lb. H sections lined with 4 in. by 12 in. reinforced concrete slabs (Plate 5) extending for 84 ft. from the shaft station. The drift leading south has steel

PLATE 11.



Plan and Section of 406 ft. Station

sets 12 ft. by 8 ft. in the clear, with 6-in. 23.8-lb. H sections for posts and 10-in. 25-lb. I-beams for caps with 4 in. by 12 in. reinforced concrete slabs (Plate 5) for lining a distance of 210 ft. from the shaft station. This drift is double tracked with drainage launder between the tracks covered over for a walk-way. Motor haulage will be used on this level.

When the level drifts were well under way, the opening for the pockets was cut and the steel put in. The main pocket is 8 ft. by 24 ft. by 9 ft. deep with the bottom on an angle of

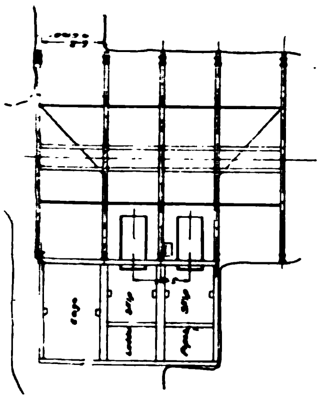
47 degrees. Chutes with finger stoppers lead from this main pocket to an auxiliary pocket for each skip, each pocket holding one skip of ore when full. These are filled from the main pocket while the skip is being hoisted and as soon as the skip is in place for loading, the tiller wheel opening the door is thrown over and the ore falls into the skip, the door closing of its own weight. A skip can be filled almost before the

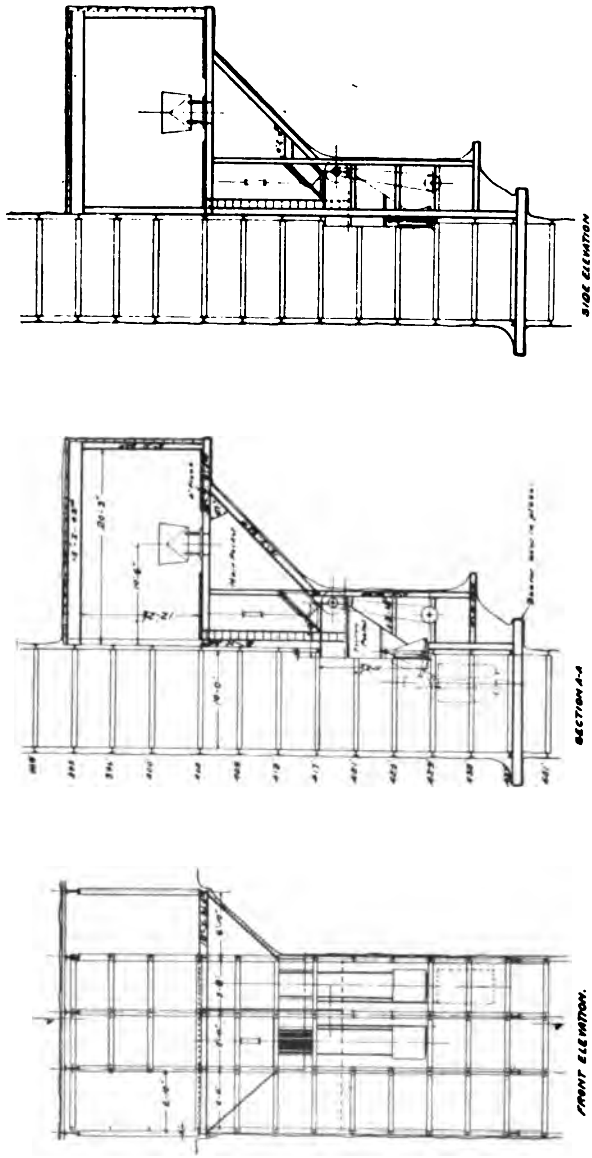
Plate 12. Shaft Station 405 ft. Level

engineer can reverse his engine. Plate 13 shows the arrangement of these pockets.

The ore, outside of the pit limits in the upper ore body, had been planned to be mined out from the open pit but it was decided to mine this ore through the shaft and thereby save a number of years in the mining of the ore. Accordingly a level was driven at a depth of 92 ft. from the collar. Steel sets with concrete slabs in the back were used for the station

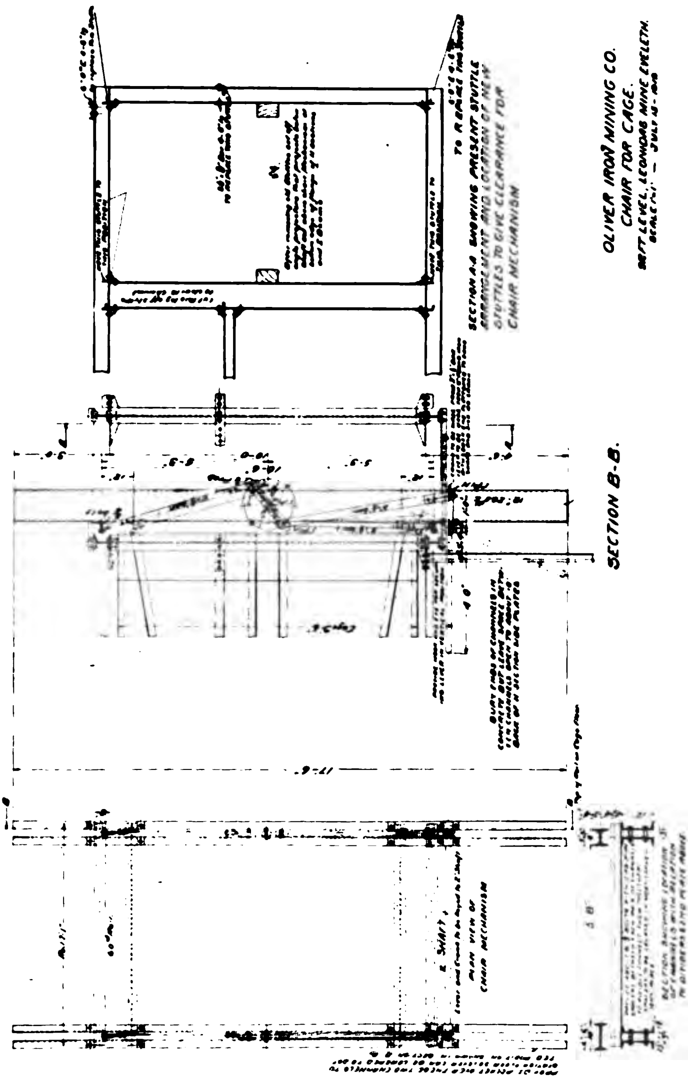
PLATE 13



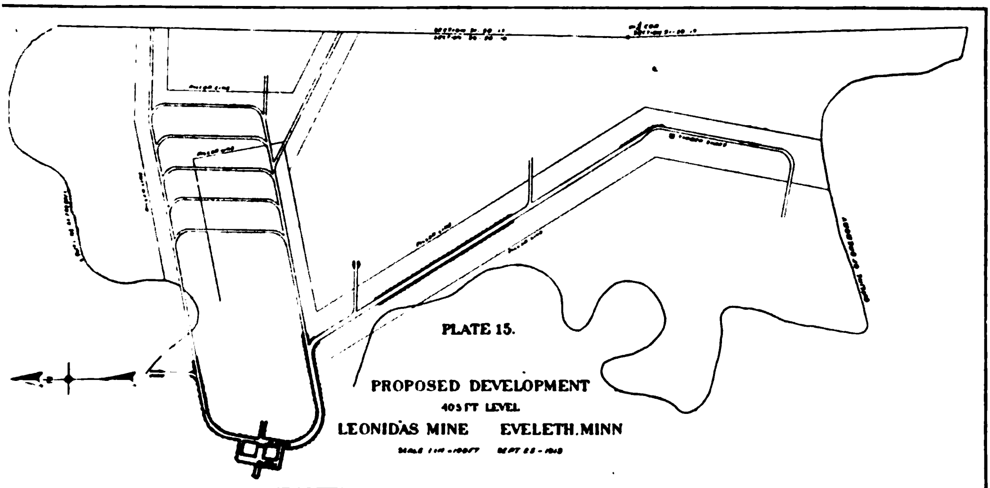


Ore Pocket at 405 ft. Level,
No. 1 Shaft

PLATE 14.


SECTION B-B.
OLIVER IRON MINING CO.
CHAIR FOR CAGE.
PLAN VIEW OF CHAIR MECHANISM

which extended back the full width of the shaft for 16 ft. The drift extending on from the station has steel sets same as in the south drift of the 405 ft. level, 12 ft. wide but with concrete slabs in the back only. These extend for 125 ft. from the station. As it was necessary to hoist the ore from this level on the cage and it was found that, without chairs, the cage settled so much when the loaded car was being pushed on it that occasionally one stood on end, it was necessary to design chairs to suit the equipment. The chairs used are shown in Plate 14. These chairs have to be held in place for the

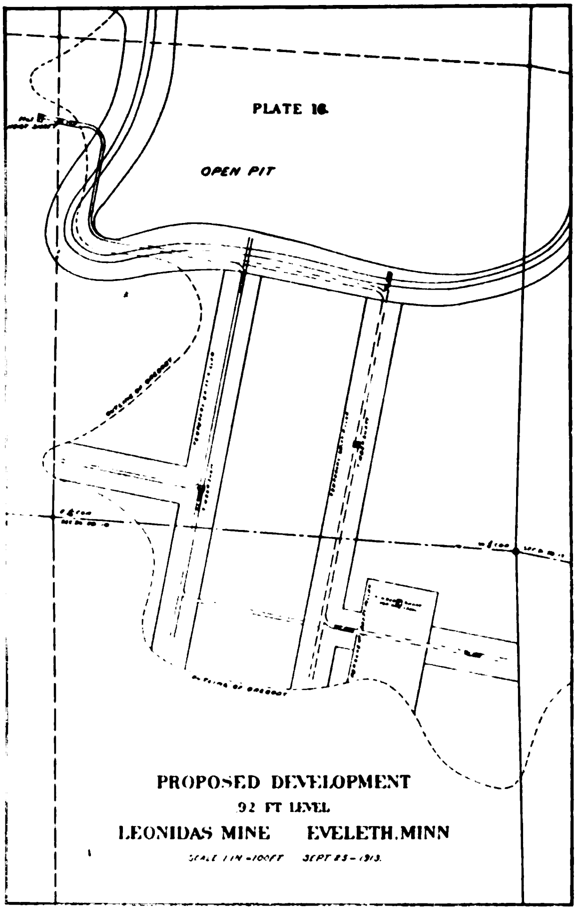


cage to rest on and when the cage is lifted off, they move back out of place, leaving the shaft clear. Motor haulage will be used on this level.

The lay-out of the main tramming drifts on the main level, (405 ft. level), is shown in Plate 15. The lay-out of the main tramming drifts on the 92 ft. level is shown in Plate 16.

The wires of the lighting system are carried in conduits throughout and every endeavor was made to have the conduits water tight. The positive line down the shaft is a No. 10 double-braid, rubber covered, crown cable and the various circuits below are of No. 12 duplex rubber covered wire.

The pump station has 18 60-Watt Mazda lamps with 10 in. aluminum reflectors, the entry drift 5 and the clear water station 3 lamps of the same size. These light up the station in excellent shape.



The main station has 4 100-Watt Mazda lamps with 12 in. aluminum reflectors. The lights in the tramming drifts are 16 candlepower carbon lamps and are placed every 50 ft. along the drift.

THE NEW CHANGE HOUSE AT VULCAN MINE.

BY FLOYD L. BURR, VULCAN, MICH.*

No meeting of the Institute and volume of its Proceedings seems to be entirely complete without a paper describing the latest and best miner's "dry" or change house. Therefore for the sake of such completeness, I shall attempt a short description of a change house recently built at the East Vulcan Mine of Penn Iron Mining Company.

Early in the spring of 1912, the old imperfect and inadequate, wooden structure known as the "dry" burned down, and brought to the point of early decision the previously considered project of building a new and modern change house.

At this time and in previous years, a large amount of study and thought had been given to the question as to what would constitute an ideal change house. The principal requirements named in the order of their relative importance seem to be: Perfect facilities for the drying, warming and otherwise caring for the miner's digging clothes, suitable provision for washing off the dirt accumulated on the hands and face during the day's toil underground; a comfortable and convenient place for changing from street clothes to underground clothes or vice versa; satisfactory provision for the safe and convenient storage of the miner's street clothing during his absence underground; good emergency hospital facilities; and toilet arrangements comprising sanitary closets, urinals and shower baths. Good lighting, heating, ventilation, plumbing, fire resistance, and good construction generally, are to be considered necessary features in the attainment of the principal requirements just mentioned. They are means toward an end.

*Structural Engineer, Penn Iron Mining Co.

The matters of permanence and economy of operation and maintenance, have to do both with general policies of management and with local conditions, such as the value, size and permanence of the mine for which the equipment is planned. Of course there must always be in the mind of the designer a continuous conflict between the awful ogre, cost, and the beautiful goddess, perfection.

The decision was to build a permanent, substantial, convenient, sanitary change house of fire resistant construction at minimum cost without considerable attention to architectural beauty. Minimum cost implies minimum size of building. It was considered necessary to provide for at least 150 men with the possibility of taking care of 250 men if occasion should require.

The first mentioned requirement of caring for the underground clothing was given much consideration, many schemes being drawn up and rejected for one reason or another. The scheme finally adopted is in a general way one that has a wide use in some parts of Europe and in a few places in America. By this scheme the clothes are hung upon suitable hooks which are afterwards hoisted up out of reach to dry and aerate. One of the most extensive and widely known installations of this sort in America is located at the Marianna Coal Mine in Washington County, Pennsylvania. During the consideration of the design, a visit was paid to Marianna and the change house inspected. Through the courtesy of friends and associates, various descriptions of such installations from English and French technical journals were available. From all this data, however, only the general idea of hoisting the clothes was copied.

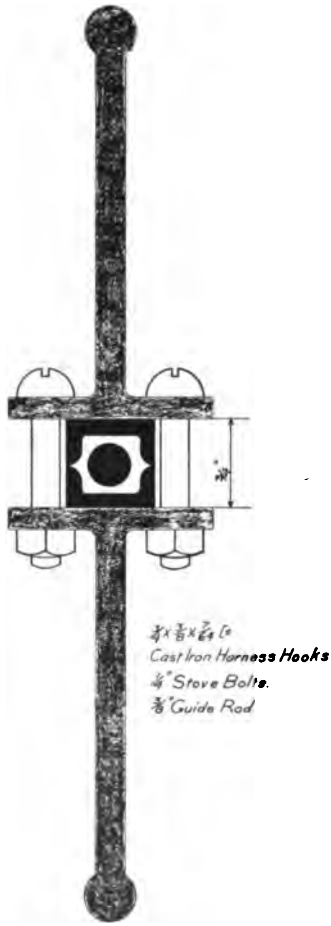
In all the previous installations of which we have knowledge one man's clothes are hung upon a single multi-pronged hook which is attached to a simple chain, not confined against swinging, and hoisted up to a more or less high ceiling. These chains or hoists have been arranged in blocks comprising at least five rows between aisles. Their use has not

been confined to the mine clothes; on the contrary the street clothes also are hung up, which practice often brings one man's street clothes adjacent to and in contact with another man's underground clothing.

According to the design adopted a cupola or monitor, extending the full length of the locker room, has been built and up into this drying chamber the clothes are hoisted. Near the base of this monitor are coils of steam pipes from the region of which quantities of dry warm air rise through and about the clothing. The monitor is surmounted at its center by a large ventilator which provides for the escape from the building of this air now laden with moisture and disagreeable odors from the clothing. The monitor is about four feet wide inside and provides for only two rows of hoists which places each row adjacent to an aisle. No street clothing is hung on these hoists, lockers being provided for them.

The supports for the mine clothes, we have chosen to call hook racks. A hook rack consists of a hollow central stem to which are attached twelve or sixteen large hooks. This central stem is made up of two channels placed flange to flange and held in that position by the pressure of the hooks which are bolted together in pairs, enclosing the stem. The stem being hollow, a space is provided which is occupied by a round steel guide rod up and down which the rack can be made to travel at the will of the operator. This guide rod is about 22 feet long and extends from an attachment at a point about a foot above the floor up to a point about a foot below the ceiling of the drying chamber or monitor. The hooks can turn about the guide rod but, of course, they are confined by it against swinging. This arrangement confines the rack to space allowed for it and prevents adjacent racks and their hoisting chains from becoming entangled. For the sake of economy each rank is assigned to two or three men and to neutralize the excessive hoisting load a counter-weight is attached to the chain. Suitable hooks are provided for holding the chain at any desired point in its travel and there are

padlocks to lock it against the evil designs of "the other fellow." These devices are attached to a horizontal 3 by 3¼ in. steel angle located at a height of about four feet above the floor. The horizontal area contiguous to each hook rack



Cross Section Through Hook Rack.

is a rectangle 21 by 24 in. and the one double row includes a total of 84 racks. These racks have been in use now for several months and seem to fulfill their purpose well, though it is not claimed that the scheme is ideal.

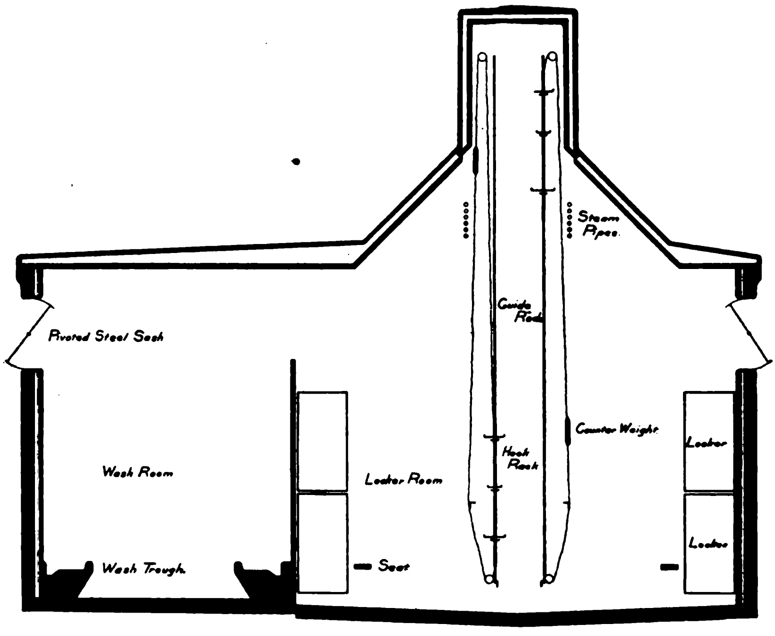
Lockers are provided for the street clothes. To economize in floor and wall space, it was decided to use double-tier lockers and in order to have them of proper height and yet be able to reach into the upper tier of lockers successfully, it was necessary to have a seat run along the front of the lockers nineteen inches above the floor and to use this seat as a step. The lockers are home-made and consist of cylinders 24 in. in diameter and 46 in. high, revolving about a central spindle. Each locker is provided with a series of 6 3-pronged hooks but has no shelf on account of limited vertical dimensions due to the double-tier arrangement. They are doorless and are closed by revolving them until the opening comes adjacent to the wall along which they are arranged. They may be locked in this closed position at the pleasure of the men who possess the keys. This type of locker is the invention of the author of this paper and his intention is to apply for letters patent upon the idea.

The available wall space gives room for 64 lockers in each tier or a total of 128 lockers. There is ample room in each locker for two men's street clothes at one time while three men would not be badly crowded. The lockers are strong and to illustrate their strength, it might be mentioned that upon several occasions a large man has been enticed into one of the lockers and the unsuspecting victim given a free merry-go-round ride therein.

The lockers and hook-racks occupy a rectangular room 17 ft. 8 in. wide and 80 ft. 4 in. long. Pivoted-ventilator steel sash windows at about 9 ft. above the floor are arranged along one side and at both ends of this room. At each end of the room is an emergency-exit door opening outward.

Connected by an open doorway with the locker room and separated from it by a partition reaching only to within some four feet of the ceiling is the wash room. This room is about 9 ft. 8 in. wide and 36 ft. 6 in. long, and contains about 70 lineal feet of wash-trough arranged on the two sides and one end of the room. The men use this trough only as

a sink or support for pails, each man providing himself with a paid to be used as a wash basin. This is standard practice at all the changing houses at the Penn Mines. The trough is made of concrete and is so shaped as to form at the back a gutter the bottom of which slopes to catch basins discharging into the sewer and into which gutter each man dumps his pail of wash water after the completion of his ablution. The bottom of the main portion of the trough slopes slightly toward

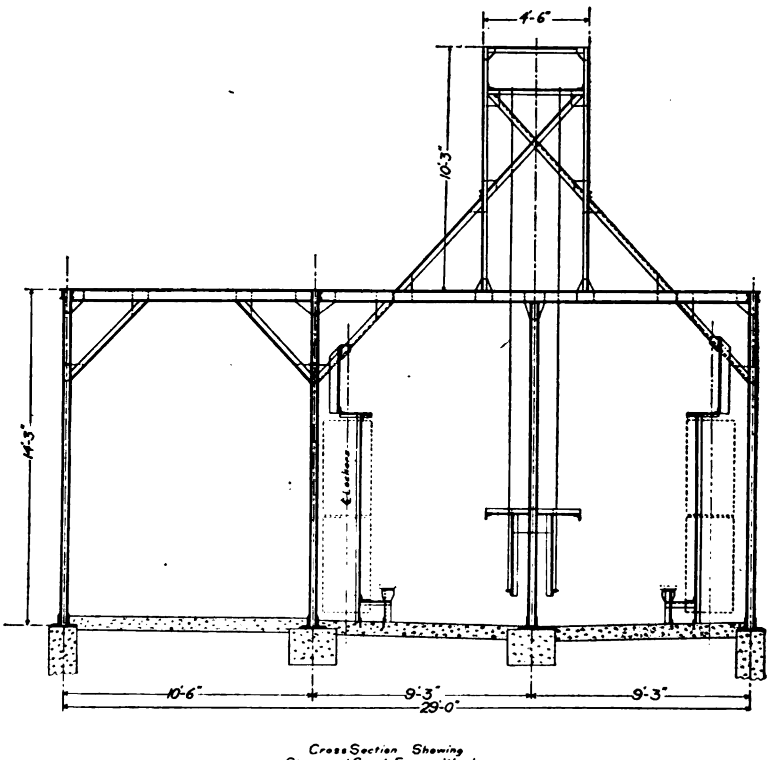


Cross Section Through Wash Room and Locker Room.

the gutter so that water dumped upon it goes immediately into the gutter and one man's wash water does not inconvenience his neighbor. Hot and cold water is on tap at three foot intervals along the length of the trough. A coil of steam pipes attached to the wall just above the water pipes gives heat to the room.

In working out the floor plat only a small space seemed to be available for first aid purposes. This room is 9 ft. 3 in. wide by 9 ft. 11 in. long and may prove to be rather

cramped when equipped with the hospital apparatus needed for such a place. However, there is a very high ceiling and by a proper use of the space overhead, the floor area may be conserved and found sufficient when the equipment is in. In order to give the room sanitary qualities, a heavy coating of enamel has been applied to the floor, walls and cealing.



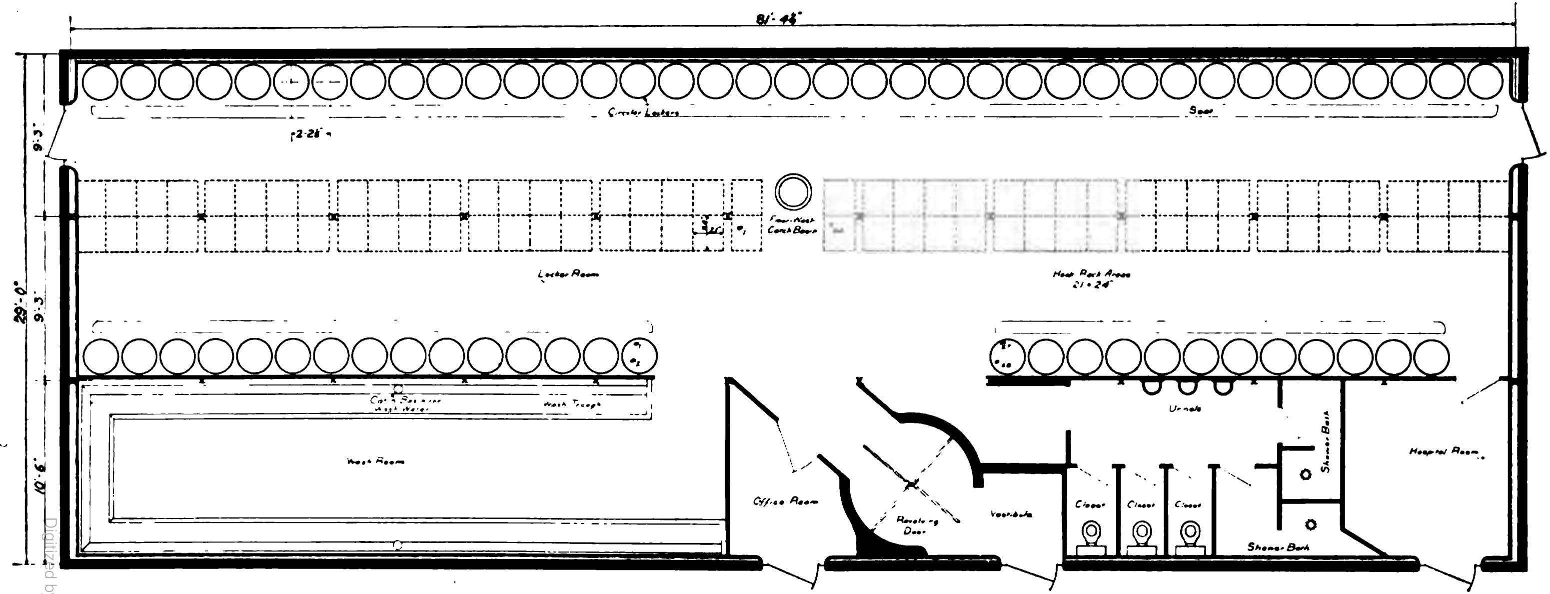
Cross Section Showing Structural Steel Frame Work

The irregular shaped office room is also something in the nature of a left-over and there was some doubt of its being adequate, the floor area being only about 45 feet. However since it has been in use, it seems to be large enough for its purpose. The shift bosses go into it to write their daily reports but its greatest use is by the dry man who uses it to dispense carbide as well as for an office where he stands in taking the numbers of the men going on shift.

The toilet room is of ample size and contains two shower baths, three urinals and three closets. Each shower room has a vestibule where the bather may disrobe and hang up his clothes. The fixtures are of the ordinary type without mixing chambers. The urinals are high grade and arranged for ample flushing. The closets are high grade, automatic in action and are equipped with white enamel iron tanks. They have proven to be extremely satisfactory in use, and as yet no difficulty has been experienced in keeping them perfectly clean. They flush in every way similarly to an ordinary non-automatic, low tank closet, except that the removal of the occupants weight from the seats takes the place of the usual act of pulling a chain, pushing a button, or otherwise voluntarily operating a lever. In the opinion of the writer of this paper, they are far superior to the closed or air-pressure-tank type of automatic closet.

Considerable thought was given to the subject of a proper entrance to the building. The shortcoming of most existing change houses was recognized in that there is no adequate provisions against a current of cold winter air blowing in through open doors upon men half naked in the operation of changing and washing. It was decided to have a revolving door, built of steel and asbestos, this has been built at our own shops and is about to be set up.

One of the conditions most essential in a modern change house is perfect cleanliness and it was necessary in the design to so arrange that the dry man could clean up each morning with a minimum expenditure of time and labor and with a maximum degree of perfection. The floor of the building which, of course, is of concrete, is so built that it slopes from every point in the building down to a large central catch-basin located in the center of the locker room. There is an exception to this statement in that the floor in each of the shower-bath rooms slopes locally to a small catch basin. This large catch basin is so provided with trap, screen, and flushing arrangements that the dryman may with impunity wash



Plan and Floor Plan

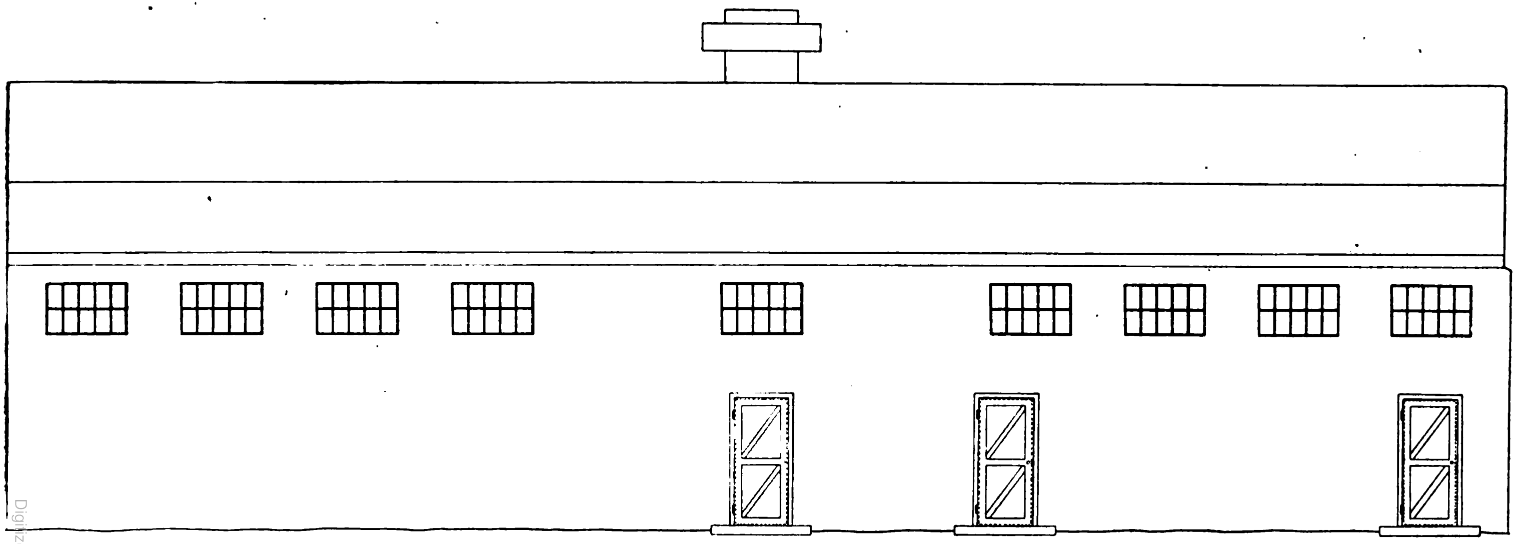
all dirt and litter down to it. Sticks, matches, tobacco bags, discarded hats, all land at the catch basin, and, of course, there are large quantities of ore and jaspar that go the same way. The building is so piped that at five different points a one-inch hose may be readily attached for this floor washing. One 25 ft. length hose is sufficient to reach every part of the building.

Compressed air is piped into the building and is on tap at several points where a small hose may be attached for blowing dust from the tops of lockers or other points of lodgment.

The building is heated by steam, piped in from the boiler house. The coils located in the various rooms are each provided with valves so that the temperature of the different rooms may be regulated separately. The steam pipe located in the monitor are in four coils, thus allowing special regulation there, to suit the season, or special conditions. All water of condensation is discharged through a steam trap to a concrete tank located over the revolving door-way, and hot water is drawn from this tank for the wash room and shower baths.

The illumination of the building is very satisfactory, due to the high windows and to white-washed walls and ceiling. Electric incandescent lamps are provided in plentiful number for night illumination. It may be mentioned that there are a few in the entrance way and main aisle that stay on all night while the great majority are switched on only at times when the men are in the building. The lights are arranged on several sub-circuits for the sake of economical control. The main switches and all the sub-switches are located in the office room excepting one located in the hospital room to control the lights there.

The building is of fire resistant construction throughout. It is not fire-proof in a strict sense because many steel members are exposed, but considering the contents of the building there is practically no risk of any fire sufficient to injure the structure. The nucleus of the building is a structural steel



Elevation of South Side

frame of somewhat unusual design. The outer columns are merged into a 6 in. concrete wall and the roof beams support a concrete roof. Inside of the 6 in. concrete wall is a 2 in. air space, a layer of No. 1 tarred felt, a ½-in. air space, and last of all a 1-in. slab of cement plaster. The roof consists of a 1½ in. slab of concrete, below that an air space, a layer of asphalt mastic wall board, another air space, and at the bottom a 2-in. slab of concrete. The partitions consist of cement plaster walls 2 in. thick. Some of these partitions reach entirely up to the ceiling, while others of them reach only part way up. All the concrete and plaster work is reinforced with "Trussit" and "Self-Centering," furnished by the General Fire-Proofing Company. The steel window sash came from the Trussed Concrete Steel Company. Wooden storm sash are provided, to be used in winter. They are applied inside the regular sash. The roof inclusive of sides and top of monitor is water-proofed by the application of Carey's Flexible Cement Roofing, with a surfacing of asphalt. The exterior of the walls is uniformed and slightly tinted by the application of "Trus-Con Stonetex." The interior of all walls and ceiling except in the hospital room are treated with white-wash. For the lower five feet of the walls the white-wash was stained red by the use of powdered hematite. All the exposed steel work is painted black.

The normal capacity of the building is taken as 252 men but it might be possible to take care of more should occasion arise. A little calculation may be in order. The 84 hook racks will each hold the underground clothing of three men, making the total capacity as regards hook-racks to be 252 men. The 128 circular lockers will each normally be issued to two men, one man on day shift and one man on night shift, which would total 256 men, approximately the same as the hook racks accommodate. However these lockers will easily hold two men's clothes at one time and on a pinch three men can crowd their clothes in. Therefore it would be practicable to assign each locker to two men on each shift and each locker

would thus take care of the street clothes of four men. By thus assigning the lockers, only 63 of the 128 would be needed to equal the capacity of the hook-racks, and 65 lockers would be empty. Now there are a good many miners who work in dry places who could get along with the circular lockers for both street and mine clothes. Two men could easily occupy a locker together in this way and the 65 lockers could thus be made to accommodate at least 130 men. By this arrangement the capacity would be 252 plus 130 or 382 men. In computing the cost per man however, a capacity of 252 men is considered.

The work of construction has all been done by the regular mine force and, as is usual when done in that way, has dragged along so that even yet there are a few things to do, such as hanging permanent doors in place of rough temporary ones, supplying seats and hooks in shower bath rooms, and equipping the hospital. Estimating the cost of the few items yet to be finished, the total cost amounts to $10,325.00. This cost includes excavation, grading, building and construction, piping, sewerage work inside and outside of building, wiring, experimental work, and equipment. For a capacity of 252 men this amounts to a cost of about $41.00 per man.

DISCUSSION

MINING METHODS ON MISSABE IRON RANGE.

(Discussion of the Paper of Willard Bayliss, E. D. McNeil, and J. S. Lutes, Committee, p. 133).

William Kelly, Vulcan Mich: The paper just read gives us an exceedingly clear idea of the varying conditions which are met with in mining on the Missabe and the modifications of the general methods which have been worked out in practice to meet these conditions. The statements are so clearly made that there is little room for discussion.

One matter not touched on that might give additional value to the paper is the percentage of ore recovered or conversely the loss of ore in the methods that are being used on the Missabe Range. I am very strongly of the opinion that the underground methods used here result in the saving of a very high percentage of the original amount of commercial ore in the ground, and if this is the case, and an estimate can be made, the figures should have a place in this paper so that the methods perfected in this district may receive the credit to which they are justly entitled.

Pentecost Mitchell, Duluth, Minn: I think that Mr. Kelly's suggestion is a good one, and that matter ought to be brought out. At various times estimates have been made and checked up very closely by some of the mining companies and the representatives of the fee owners.

REPORT OF COMMITTEE ON THE PRACTICE FOR THE PREVENTION OF ACCIDENTS.

(Discussion of the Paper, p. 31).

William Kelly, Vulcan, Mich: Mr. President, I take it that this report is merely a report of progress, and that we can look forward to a more extended report later. Am I correct in that hope and expectation?

Secretary: I will say that the Committee has prepared this classification in the hope that it would get the matter started, and they are very anxious to receive suggestions regarding the classification. They believe that it would be advisable to make reports conform to the reports of the Bureau of Mines, and this paper sets forth the classification adopted by the Bureau at the present time. If any of the mining companies desired to carry the detail a little further they could still use the general captions and elaborate their reports to suit requirements.

Pearson Wells, Ironwood, Mich: I notice that one of the objects of the Committee was to do some work on uniform mine accident laws. I have here a copy of the report on that subject by the Committee appointed by the American Mining Congress. The Technical Society of Colorado went over these proposals for uniform mining laws and changed them to a considerable extent. I would like to put this into the hands of the Chairman of the Committee, but since he isn't here I will hand it to the Secretary. I think the Committee can find something of value in it. The Colorado Committee was to report to the American Mining Congress and also to the American Institute of Mining Engineers, and discussion, suggestions and criticisms by other bodies interested in mining, and from mining men in general, were invited by the original Committee.

(The report referred to is the "Proceedings of the Colorado Scientific Society, Vol. X, pp. 279-414," July, 1913).

MINE LAWS, SPECIAL RULES AND THE PREVENTION OF ACCIDENTS.

(Discussion of the Paper of E. B. Wilson, Scranton, Pa., p. 103).

EDWIN HIGGINS, Ironwood, Mich: On page 111 of this volume there appears a cut of a danger sign. The only reference to it in the text is where the writer states:

"In the absence of state mine laws to govern metal mining, it certainly is advisable that the operator appoint a safety committee, make a uniform set of mine rules, make use of danger signs, and also issue from time to time safety pamphlets for the miners all over the fields, calling attention to the accidents that have happened and how they may be avoided."

There is a publication to come out shortly by the Bureau of Mines, on the use of mine signs in metal mines, and an important feature of that paper will be the recommendation of three universal signs. The Bureau has requested me, if possible, to get some discussion or some expression of opinion on these signs which it will recommend. Unless there is some objection to them by some mining body or institution in some part of the metal mining country, these signs will be recommended by the Bureau as universal signs. They are as follows:

1. Universal danger sign: A circular red ball painted on a white background.

2. Universal safety sign: An arrow painted in any distinctive color. This may be used also to indicate the direction to outlet shafts, main drifts, etc.

3. Universal sign indicating ladderways: A ladder painted in a dark color on a light colored background.

PEARSON WELLS, Ironwood, Mich: This suggestion came up at the last meeting of the Mine Association of the Gogebic Range. Although we haven't come to any definite conclusion on the matter, I think that the Association will be in favor of adopting anything that the Bureau recommends. I say this for the benefit of the operators on the other ranges. I can't say definitely that we will resolve to adopt it on the

Gogebic Range, but it certainly looks like a good thing to us because the more general these things can be made the better it is for all concerned. Our men are migrating from place to place a great deal, and if we can educate them up to the universal signs it is bound to help a great deal on all the ranges. Mr. Higgins tells me that the Mining Association in the Iron Mountain district also look upon these universal signs favorably, in fact, I believe they have resolved to accept what the Bureau proposes.

SAFETY IN THE MINES OF THE LAKE SUPERIOR IRON RANGES.

(Discussion of the Paper of Edwin Higgins, Ironwood, Mich., p. 63).

A. H. FAY, Washington, D. C: Three years ago I visited the iron ranges of Minnesota and Michigan and in passing through a number of machine shops and also around the headframes, hoisting plants, etc., I noticed that some of the companies were putting up guard rails and other safety devices on machinery, stairways and ladderways. This, however, was only in a few places. These guard rails and other safety devices were still fresh from the planing mill with scarcely a grease mark on them, indicating that the work was of recent date. I find today that practically all of those have been replaced by pipe and substantial frames of various kinds. This is not only at a few mines, but at many. The gearing of lathes has been enclosed; wire netting has been placed in front of other dangerous machinery; emery wheels have been covered with sheet iron; and band and circular saws have been encased. Stairways of heading frames, and in shops as well, have been provided with hand rails, and shaft openings provided with automatic gates or covers. In addition to all of these mechanical improvements there has been in progress a campaign of education among the miners, foremen, and operators all of which has resulted in a decrease in the fatality rate in the Lake Superior district. This decrease is shown in the following tabulation of fatalities for 1911 and 1912.

FATALITY RATES IN MICHIGAN AND MINNESOTA COMPARED FOR THE YEARS 1911 AND 1912.

	Number Killed.	Number Killed Per 1,000 Employed.
Michigan iron mines, 1911	69	4.67
Michigan iron mines, 1912	52	3.62
Michigan copper mines, 1911	63	3.80
Michigan copper mines, 1912	44	2.96
Michigan total for all mines, 1911	134	4.24
Michigan total for all mines, 1912	96	3.25
Minnesota iron mines, 1911	76	4.57
Minnesota iron mines, 1912	50	3.02

It will be noted from the above table that the fatality rate has been decreased practically one unit in each case, and it is hoped that with the good work that is being done in the iron and copper mines of Lake Superior district that a still further reduction in the fatality rate may be obtained:

PENTECOST MITCHELL, Duluth Minn: The figures submitted by Mr. Fay are very interesting, and I think they should be included in our proceedings here this evening as showing the progress that has been made during the last few years. I think this has been general over the whole Lake Superior country.

BIOGRAPHICAL

BIOGRAPHICAL NOTICES.

CHAS. T. HARVEY.

Born in 1829, in Connecticut. In his youth he worked as a clerk for Josiah Wright, in a grocery store, and later on he became traveling salesman for the Fairbanks Scales Company. In 1852 he came to Marquette, an invalid, seeking health after a severe attack of typhoid fever at his home in Connecticut. At that time he represented, as western agent, the Fairbanks Scales Company and looked after their business when he first came.

During his visit at Marquette he saw, as had many others, the necessity for the locks at Sault Ste. Marie and busied himself immediately in starting such a project. Standing six feet two inches, with great personal magnetism, he soon overcame all opposition to such a project in the state legislature, and organized the Sault Ste. Marie Canal & Land Co., with the necessary capital to complete the canal.

A government land grant of 750,000 acres was given for the building of the canal, and Mr. Harvey was placed in charge of the project and personally superintended the construction of the canal, which was completed in 1855.

In 1857 Mr. Harvey organized the first company to build a blast furnace in northern Michigan. It was called the Pioneer furnace and was located in Negaunee. This company was later on absorbed by the present Pioneer Iron Company, with furnace at Marquette.

He also obtained a charter for the building of a railway from Ishpeming to Escanaba in the early sixties and which is now the Peninsula division of the C. & N. W. R'y.

Later he was awarded a state appropriation for the best

rapid transit system in New York city, which was the elevated street railway.

Throughout his life he was continually promoting enterprises of great public importance but from which he gained but little for himself. His ability in such matters and good judgment in their direction won wealth to many but in which he seldom shared. He died in New York city March 14, 1912.

Louis W. Powell.

Louis Weston Powell was born at Wytherville, Va., and was a graduate of Washington and Lee University. For a time he was employed in the iron mines, at Virginia, coming to the Palms mine, at Bessemer in 1896.

In 1900 he became connected with the Oliver Iron Mining Company, at Duluth, as assistant to the president. He remained with this Company, as assistant general manager, until 1906, at which time he became general manager for the Calumet & Arizona Mining Company, at Bisbee, Arizona. In 1910 he resigned this position and was interested for a number of years, until his death, in promoting different mining companies in Mexico and the Southwest. At his death, which occurred in New York on October 24, 1913, he was president of the Elenita Development Company, vice president of the Cananea Copper Company, and a director in other copper mines.

Dr. George Koenig.

Born in Germany, 1845. Educated in Heidelberg. He came to America in his youth and taught chemistry for twenty years in the University of Pennsylvania. He established the first course in mining ever taught in the United States. In 1892 Dr. Koenig joined the Michigan College of Mines, at Houghton, as professor of chemistry.

He had a kindly humor and his lectures were very popular with the students because he illuminated them with quiet fun at times.

He died January 14, 1913, at Philadelphia, of arterio scleresis.

His works on chemistry are used as text books at the Michigan College of Mines and other colleges.

A. Lanfear Norrie.

Born in 1858; his early home was in New York city. He received part of his education in England. Came to the Northern Peninsula in 1885 and, having some capital, commenced to explore on the then new Gogebic range. He located the Norrie mine in 1885 and 1886 and then retired from his mining work, living principally in New York city. He died there December 22, 1910.

Graham Pope.

Mr. Pope was born in the city of Boston, Mass., October 12, 1840. He was educated in the public schools there and, for a year following his student life, worked in a nautical and scientific instrument shop. He then took a position in a large mercantile house and there gained a business education.

In 1861 Mr. Pope came to Houghton and entered the employ of the Isle Royale Mining Company with the intention of following mining work thereafter. He was made treasurer and manager of the Houghton Copper Works in 1871 and continued this work for two years until the concern had to close in 1873 for lack of capital. Then for a few years Mr. Pope was engaged on tribute mining, until 1878, when he became a member of the firm of Pope, Shepherd & Co., later becoming sole owner.

In 1892 Mr. Pope again entered the mining field, as manager of the Franklin Mine, and again gave up mining in 1899 owing to the pressure of his private affairs. He also closed his mercantile business and retired to private life.

During the Civil war Mr. Pope was a lieutenant in Company I, Twenty-Third Michigan Volunteer Infantry, and was largely instrumental in recruiting this Houghton county com-

pany. He was the donor of the soldiers' monument in Houghton, dedicated May 30, 1912.

Mr. Pope was president of the Lake Superior Mining Institute for the year 1900 and was always an enthusiastic supporter and member of the same.

In 1864 he married Miss Alice H. Fielder, of Houghton, who died in 1876, and they are survived by one son and three daughters. He died Sunday, July 8, 1912. An active, aggressive man, throughout his entire life, which was nearly all spent in the upper peninsula; he also possessed those qualities that drew from his associates their honor, respect and affection. At his death there were few in the Lake Superior region that stood as high in the estimation of those engaged in the business of mining.

EDWIN J. HULBERT.

Born at Fort Brady, Sault Ste. Marie, April 30, 1829. He was a son of John Hulbert, of Sault Ste. Marie, and a nephew of Henry W. Schoolcraft, the historian. He was employed in 1857 on the survey of the state road from Copper Harbor, by way of Eagle Harbor Cliff and Houghton, to Ontonagon and, during that time, the first discoveries of conglomerate boulders were made.

He purchased lands which he thought contained copper veins and, in 1864, discovered the Calumet conglomerate lode in a pit sunk by John Hulbert, Jr., and Amos Scott. No. 4 shaft, Calumet mine, marks the site of the pit in which the discovery was made.

Mr. Hulbert had the first survey made for the Portage Lake canal, the work being done by W. H. Hearding, then of Houghton. For this survey he personally paid. The work was afterwards completed by the government. During his discovery of the Calumet & Hecla conglomerate, Mr. Hulbert acquired large tracts of land in the vicinity of the original pit, the Tamarack Mine being situated upon some of them.

For various reasons he lost almost all his holdings and, not wishing to remain in the United States, moved to Rome, Italy, where he died October 20, 1910.

Anson B. Miner.

Born in Illinois in 1846. He entered a Chicago banking institution at an early age in the capacity of office boy. He soon gained a knowledge of the banking business and advanced rapidly until he was appointed as cashier, a position which he filled until 1874, when the bank was burned out and he was forced to journey to the West because of ill health. He returned to Chicago after an absence of several years and took a position with the First National Bank, remaining there until 1883 when he went to Ishpeming as cashier of the First National Bank of that city. The bank was reorganized later, the name being changed to the Miners' National Bank, and Mr. Miner was named as cashier and managing director.

He was one of the keenest bankers in the Upper Peninsula and his advice was sought by many. He took a great deal of interest in the mining business of the country and never failed to attend the sessions of the Institute.

Mr. Miner was married to Miss Colter, of Ontonagon, at Ishpeming, and one daughter, Mary Miner, was born to them. He died at Ishpeming on January 13, 1913, after a short illness.

John McEncroe.

Born at Detroit, Michigan, in 1834. Twenty years later he left his native city and started for the Upper Peninsula, stopping first at Sault Ste. Marie, where he spent a few months, and then journeyed to Marquette. At this place he secured work on the Marquette, Houghton & Ontonagon Railway, which was then being built. In 1856 he went to work at the Eureka Mine, located a short distance from Marquette. The property was operated by A. B. Ward and

the ore was of the bog variety and was sent to the Wyandot furnace for smelting. The mine soon played out as the deposit was small.

In 1858 Mr. McEncroe went to Ishpeming to enter the employ of the Lake Superior Iron Company and he remained in the service of that company for 53 years, being placed on the pension roll a few years prior to his death. He was one of a little band of ten working under Gilbert D. Johnson, the Company's first superintendent. His first work was that of a miner, working in the open pits, for which he received seventy-five cents per day. In 1860 he was promoted to the foremanship of one of the pits. In 1865 he was made foreman of all of the pits and all of the surface work.

In 1873 Mr. McEncroe was made mining captain of all of the Company's hard ore mines, a position which he held continuously until he retired, with great credit to himself and profit to his employers. Captain McEncroe needs no greater compliment to his ability as a miner; to his organization of a working force, or to his character as a stable citizen than the simple statement that he had been engaged with one company for fifty-three years. He entered the Lake Superior field when there were but a few mining properties and the methods of extracting ore were crude, and the experiences that he often related of the early days on the Marquette range were highly interesting.

He was the oldest resident of Ishpeming, Mich., at the time of his death, which occurred on April 23, 1913.

PAST OFFICERS.

PRESIDENTS.

Nelson P. Hulst	1893	George H. Abeel	1903
J. Parke Channing	1894	O. C. Davidson	1904
John Duncan	1895	James MacNaughton	1905
William G. Mather	1896	Thomas F. Cole	1906
William Kelly	1898	Murray M. Duncan	1908
Graham Pope	1900	D. E. Sutherland	1909
W. J. Olcott	1901	William J. Richards	1910
Walter Fitch	1902	F. W. Denton	1911

Pentecost Mitchell. 1912

(No meetings were held in 1897, 1899 and 1907.)

VICE PRESIDENTS.

1893.

John T. Jones F. P. Mills	J. Parke Channing	Graham Pope M. W. Burt

1894.

John T. Jones F. P. Mills	R. A. Parker	Graham Pope W. J. Olcott

1895.

F. McM. Stanton Geo. A. Newett	R. A. Parker	Per Larsson W. J. Olcott

1896.

F. McM. Stanton Geo. A. Newett	J. F. Armstrong	Per Larsson Geo. H. Abeel

1898.

E. F. Brown James B. Cooper	Ed. Ball	Walter Fitch Geo. H. Abeel

1900.

O. C. Davidson T. F. Cole	M. M. Duncan	J. H. McLean F. W. Denton

1901.

J. H. McLean M. M. Duncan	Nelson P. Hulst	F. W. Denton William Kelly

1902.

William Kelly Nelson P. Hulst	Fred Smith	H. F. Ellard Wm. H. Johnston

	1903.	
H. F. Ellard		Wm. H. Johnston
Fred Smith	James B. Cooper	John H. McLean
	1904.	
H. F. Ellard		John H. McLean
Wm. H. Johnston	Fred Smith	James B. Cooper
	1905.	
M. M. Duncan		John H. McLean
Fred M. Prescott	F. W. McNair	J. B. Cooper
	1906.	
M. M. Duncan		F. W. McNair
J. M. Longyear	Fred M. Prescott	F. W. Denton
	1908.	
J. M. Longyear		D. E. Sutherland
F. W. Denton	David T. Morgan	Norman W. Haire
	1909.	
W. J. Richards		D. E. Sutherland
Charles Trezona	D. T. Morgan	Norman W. Haire
	1910.	
W. J. Richards		Charles Trezona
John M. Bush	Frederick W. Sperr	James H. Rough
	1911.	
E. D. Brigham		C. H. Munger
John M. Bush	Frederick W. Sperr	James H. Rough
	1912.	
E. D. Brigham		C. H. Munger
Geo. H. Abeel	W. P. Chinn	W. H. Jobe

MANAGERS.

	1893.	
John Duncan		James MacNaughton
Walter Fitch	William Kelly	Charles Munger
	1894.	
Walter Fitch		C. M. Boss
John Duncan	M. E. Wadsworth	O. C. Davidson
	1895.	
F. P. Mills		C. M. Boss
Ed. Ball	M. E. Wadsworth	O. C. Davidson
	1896.	
F. P. Mills		Graham Pope
Ed. Ball	C. H. Munger	William Kelly
	1898.	
M. M. Duncan		Graham Pope
J. D. Gilchrist	T. F. Cole	O. C. Davidson
	1900.	
E. F. Brown		Walter Fitch
Ed. Ball	James B. Cooper	George H. Abeel

	1901.	
James B. Cooper		James Clancey
James MacNaughton	(One Vacancy)	J. L. Greatsinger
	1902.	
James Clancey		Graham Pope
J. L. Greatsinger	Amos Shephard	T. F. Cole
	1903.	
Graham Pope		T. F. Cole
Amos Shephard	W. J. Richards	John McDowell
	1904.	
John McDowell		Thomas F. Cole
Wm. J. Richards	Graham Pope	Amos Shephard
	1905.	
John C. Greenway		H. B. Sturtevant
John McDowell	William Kelly	Wm. J. Richards
	1906.	
John C. Greenway		H. B. Sturtevant
Jas. R. Thompson	William Kelly	Felix A. Vogel
	1908.	
James R. Thompson		J. Ward Amberg
Felix A. Vogel	John C. Greenway	Pentecost Mitchell
	1909.	
F. E. Keese		J. Ward Amberg
W. J. Uren	L. M. Hardenburg	Pentecost Mitchell
	1910.	
Frank E. Keese		L. M. Hardenburg
Charles E. Lawrence	William J. Uren	William J. West
	1911.	
Charles E. Lawrence		William J. West
Peter W. Pascoe	J. B. Cooper	L. C. Brewer
	1912.	
Peter Pascoe	J. B. Cooper	L. C. Brewer
M. H. Godfrey		J. E. Jopling

TREASURERS.

C. M. Boss 1893
A. C. Lane 1894
Geo. D. Swift 1895-1896
A. J. Yungbluth 1898-1900
Geo. H. Abeel 1901-1902
E. W. Hopkins ....1903-....

SECRETARIES.

F. W. Denton 1893-1896
F. W. Denton and F. W. Sperr..............................1898
F. W. Sperr 1900
A. J. Yungbluth ....1901-....

LIST OF PUBLICATIONS RECEIVED BY THE INSTITUTE.

American Institute of Mining Engineers, 99 John Street, New York City.

Mining and Metallurgical Society of America, 505 Pearl Street, New York City.

American Society of Civil Engineers, 220 West 57th Street, New York City.

Massachusetts Institute of Technology, Boston, Mass.

Western Society of Engineers, 1734-41 Monadnock Block, Chicago.

The Mining Society of Nova Scotia, Halifax, N. S.

Canadian Mining Institute, Ottawa.

Canadian Society of Civil Engineers, Montreal.

Institute of Mining Engineers, Neville Hall, Newcastle-Upon-Tyne, England.

North of England Institute of Mining and Mechanical Engineers, Newcastle-Upon-Tyne, England.

Chemical, Metallurgical and Mining Society of South Africa, Johannesburg, S. A.

American Mining Congress, 1510 Court Place, Denver, Colo.

State Bureau of Mines, Colorado, Denver, Colo.

Reports of the United States Geological Survey, Washington, D. C.

Geological Survey of Ohio State University, Columbus, O.

Geological Survey of New South Wales, Sydney, N. S. W.

Oklahoma Geological Survey, Norman, Okla.

University of Oregon, Library, Eugene, Oregon.

Case School of Applied Science, Department of Mining & Metallurgy, Cleveland, Ohio.

University of Illinois, Exchange Department, Urbana, Ills.

University of Missouri, Columbia, Mo.

University of Michigan, Ann Arbor, Mich.

Iowa State College, Ames, Iowa.

The Mining Magazine, 178 Salisbury House, London, E. C.

Mines and Mining, 1824 Curtis Street, Denver, Colo.

Engineering-Contracting, 355 Dearborn Street, Chicago, Ills.

Mining & Engineering World, Monadnock Block, Chicago, Ills.

Mining Science, Denver Colo.

Mining & Scientific Press, 667 Howard Street, San Francisco, Cal.

The Mexican Mining Journal, Mexico City, Mexico.

Stahl und Eisen, Dusseldorf, Germany, Jacobistrasse 5.

LAKE SUPERIOR IRON ORE SHIPMENTS FROM THE DIFFERENT RANGES FOR YEARS PRIOR TO 1909, 1909, 1910, 1911 AND 1912, AND GRAND TOTAL FROM 1855 TO 1912, INCLUSIVE.

(Compiled from Report Published by Iron Trade Review).

		Prior to 1909.	1909.	1910.	1911.	1912.	Grand Tot.
Marquette Range	(Tons......	87,647,810	4,256,172	4,392,726	2,833,116	4,202,308	103,332,141
	(Per cent	21.5	10.0	10.1	8.6	8.7	18.
Menominee Range	(Tons......	66,337,670	4,875,385	4,237,738	3,911,174	4,711,440	84,073,407
	(Per cent	16.3	11.4	9.9	11.9	9.8	14.5
Vermilion Range	(Tons......	28,017,170	1,108,215	1,203,177	1,088,930	1,844,981	33,262,473
	(Per cent	6.9	2.6	2,6	3.4	3.8	6.5
Gogebic Range	(Tons......	56,732,446	4,088,057	4,315,314	2,603,318	5,006,266	72,745,401
	(Per cent	14.	9.5	10.0	8.0	10.4	12.5
Mesabi Range	(Tons......	167,548,343	28,176,281	29,201,760	22,093,532	32,047,409	279,067,325
	(Per cent	41.1	66.1	67.2	67.4	66.5	48.2
Cuyuna Range	(Tons......				147,431	305.111	452,542
	(Per cent				.4	.6	.1
Miscellaneous	(Tons......	797,868	82,759	91,682	115,629	104,031	1,191,969
	(Per cent	.2	.2	.2	.2	.2	.2
Total tons..........		407,081,316	42,586,869 Increase over 1908 63.6%	43,442,397 Increase over 1909 2.0%	32,793,130 Decrease from 1910 24.5%	48,221,546 Increase over 1911 47.0%	574,125,258

APPENDIX

·ting by The O. F. Collier Press
·avings by Duluth-Photo Engraving Co.

Duluth and the Minnesota Iron Ranges

¶ Data and views showing the scope of operations pertaining to the mining, transportation and smelting of Iron Ore in Northern
:: :: Minnesota :: ::

Compiled and arranged by

W. W. J. CROZE, Mining Engineer
DULUTH, MINN.

1913

Lake Superior Mining Institute.

LOCAL COMMITTEES FOR 18th ANNUAL MEETING.

RECEPTION

Geo. A. St. Clair, Chairman

T. F. Cole
A. L. Ordean
Jno. A. Savage
C. A. Congdon
B. W. How
R. B. Whiteside
James A. Ferguson
Jas. D. Ireland
Julius H. Barnes
Geo. D. Swift
A. D. Thomson
Jos. B. Cotton
A. M. Chisholm
H. M. Peyton
H. W. Brown
A. M. Marshall
W. J. Olcott
M. H. Alworth
C. A. Luster
Jno. G. Williams
W. N. Ryerson
G. G. Barnum
Judge Page Morris
R. B. Knox
Cuyler Adams
Capt. Alex. McDougal
Hon. E. B. Hawkins
C. A. Duncan
G. A. Tomlinson
Geo. L. Reis
J. L. Washburn
Hon. W. I. Prince
Capt. Ernest D. Peek
Joseph Sellwood
W. C. Agnew
J. B. Adams
F. D. Orr
G. G. Hartley
Chas. d'Autremont
O. W. Johnstone
Herbert Warren
F. A. Brewer
W. G. La Rue

ARRANGEMENTS

John H. McLean, Chairman

C. H. Munger
Geo. H. Crosby
D. E. Woodbridge
D. M. Philbin
R. M. Sellwood
D. L. Fairchild
Geo. D. Swift
W. W. J. Croze
W. H. Cole

TRANSPORTATION

W. A. McGonagle, Chairman

F. E. House
J. R. Michaels,
Thos. Owens
W. W. Walker
A. V. Brown
Oscar Mitchell
C. O. Jenks
J. W. Kreitter
Geo. M. Smith

ENTERTAINMENT

Francis J. Webb, Chairman

S. S. Rumsey
J. H. Hearding
J. D. Ireland
A. B. Coates
J. G. Vivian
W. J. West
L. R. Salsich
W. P. Chinn
J. S. Lutes

ITINERARY

Lake Superior Mining Institute

TUESDAY, AUGUST 26th, 1913:

Headquarters at Spalding Hotel, Duluth.

Leave Fifth Avenue dock by Steamer "Columbia" for steel plant at 2:00 P. M., returning to Duluth between 6:00 P. M. and 7:00 P. M.

Leave Duluth by special train, via Duluth & Iron Range Railroad, from Union Depot at 12:00 o'clock midnight for Aurora.

WEDNESDAY, AUGUST 27th, 1913:

Breakfast on train at Aurora. Leave at 8:00 A. M. by automobile for the following mines: Biwabik, Corsica, Elba, Schley, Pettit, Genoa, Fayal, Adams and Spruce.

Luncheon at Glode Hotel, Eveleth, 12:00 o'clock noon.

Leave Eveleth 1:30 P. M. and visit the following mines: Norman, Union, Commodore, Lincoln, Alpena and Virginia & Rainy Lake Company's saw mill.

Baseball game at 4:00 P. M. at Virginia between Northern League teams.

Dinner at Elk's Club, Virginia, 6:30 P. M.

Business meeting, Virginia High School, 8:00 P. M.

Elks Club and Virginia Club will be open in the afternoon and evening to all members of the Institute.

THURSDAY, AUGUST 28th, 1913:

Breakfast on train at Virginia. Leave at 8:00 A. M. by automobile for following mines: Brunt, Mountain Iron, Wacoutah, Kinney, Whiteside, Woodbridge, Grant and Shenango.

Luncheon at 12:00 o'clock noon at Chisholm, in Bergeron Hall.

Leave Chisholm 1:30 P. M. and visit the following mines: Leonard and Monroe.

Arrive at Fair Grounds, Hibbing, 3:30 P. M. Attend horse races.

Dinner on train at 6:30 P. M.

Vaudeville entertainment, Armory, 8:30 P. M.

Algonquin and Oliver Clubs will be open in afternoon and evening to the Institute Members.

FRIDAY, AUGUST 29th, 1913:

Breakfast on train at Hibbing. Leave at 8:00 A. M. for Hull-Rust, Burt-Pool, Sellers and Buffalo & Susquehanna Mines.

Leave on Great Northern Railway at 10:30 A. M., visiting the following mines: Stevenson, St. Paul, Bray, Hawkins, Crosby, Hill, Holman and Canisteo, arriving at Coleraine between 5:00 and 6:00 P. M.

Luncheon and dinner on train.

Moving pictures of Missabe Range mines and business meeting, Village Hall, 8:00 P. M.

SATURDAY, AUGUST 30th, 1913:

Breakfast on train at Coleraine.

Leave at 8:00 A. M. for inspection of Concentrating and Power Plants.

Leave Coleraine, via Duluth, Missabe & Northern Railway, at 10:30 A. M. for Duluth.

HISTORY *of* DULUTH

THE HISTORY of Duluth commences with Daniel de Gresolon, Sieur Dulhut, one of the explorers of the Upper Mississippi, who came to the head of the lakes in the summer of 1679. Radisson and Groseillier, and Claude Allouez, a Jesuit priest, preceeded Dulhut to the Lake Superior district, and are supposed to have visited the head of the lakes, but there is no authentic account previous to that of Dulhut.

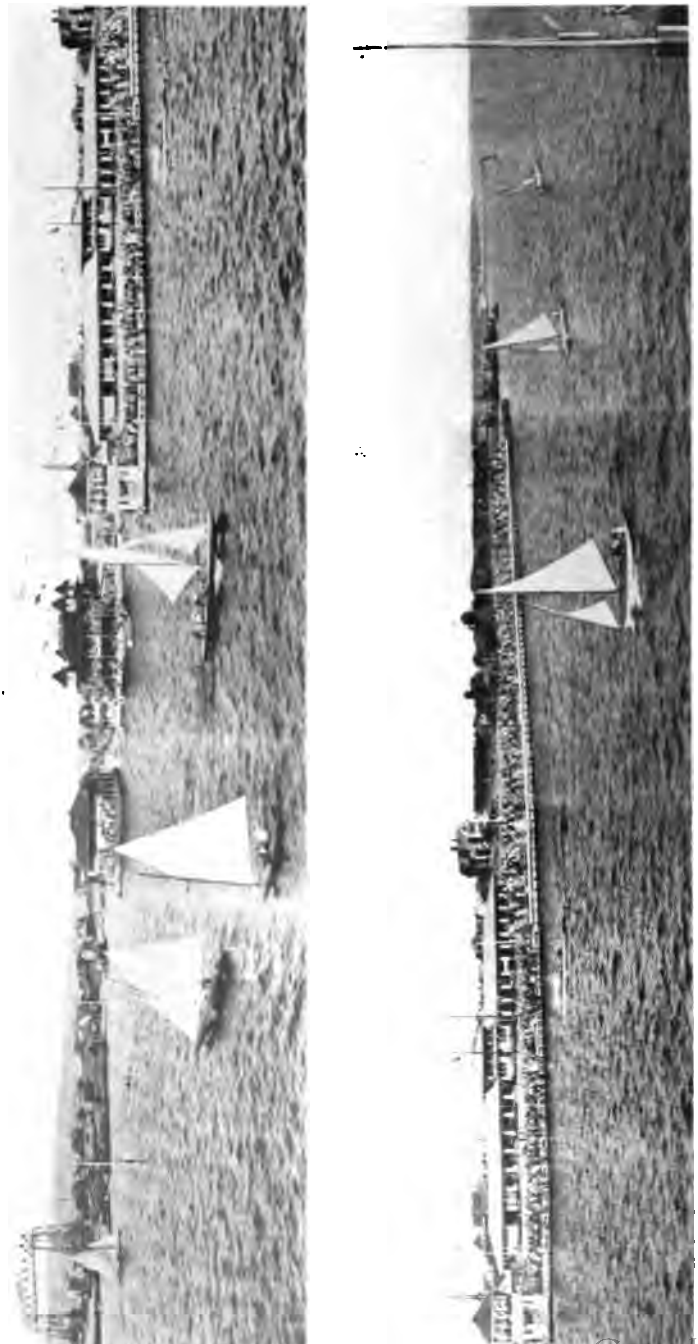
¶ In 1792 the fur traders established a fort at Fond du Lac, on the St. Louis river, 15 miles above the present city of Duluth. In the early 50's there were a few scattered squatters at Oneota and around the George Stuntz trading post on Minnesota Point. In 1855-56 the settlement on Minnesota Point was called Duluth, commemorating the name of Dulhut.

¶ The first railroad was built to the head of the lakes in 1870. The charter for this road had been granted in 1861 to the Lake Superior and Mississippi Railroad Company, afterward called the St. Paul and Duluth, and which is now a part of the Northern Pacific.

¶ In 1870 the population of Duluth was about 1,200, and Oneota 500; 1880, 3,480; 1890, 33,115; 1900, 52,969; 1910, 78,184.

Duluth, Minnesota, 1870

Duluth, Minnesota, 1912



Duluth Boat Club

St. Louis County Court House, Duluth, Minnesota

Club House, Northland Country Club

Minnesota Steel Company Shop Buildings

¶ The plant of the Minnesota Steel Company is located on the St. Louis River, nine miles from Union Depot at Duluth, on a tract of 1500 acres, with two miles of water front and connected by the Spirit Lake Transfer Ry. and Interstate Railroad, with all railroads entering Duluth or Superior. The present plans include:

Two blast furnaces—500 tons daily capacity each; thin lined, water cooled shells; 10 stoves, gas washers, etc.
Ninety Koppers type by-product coke stoves.
Ten open hearth furnaces—rated capacity 75 tons each. (Each furnace equipped with 400 h. p. boiler for utilizing waste heat.)
Four 4-hole soaking pits.
One 40-in. reversing Blooming Mill, steam driven, with low pressure turbine generator set.
One 28-in. finishing mill—Motor driven
One 16-in. continuous roughing train with
3 Stand 12-in. finishing
2 Stand 10-in. finishing
2 Stand 8-in. finishing
} Motor driven

Power house—10,000 K W capacity
Five blowing engines - gas driven, 20,000 cu. ft. capacity each.
Pumping station—40,000,000 gallons daily capacity
Machine Forge and Structural Shop.
Three continuous reheating furnaces—regenerating type, end discharge, designed to use 16-foot billets. Estimated daily capacity of 1,000 tons ingots.
All buildings steel frames, enclosed with two-piece concrete blocks.

¶ The company are also erecting 175 houses containing 350 apartments. A cement plant with a capacity of 4000 barrels per day will also be built.

Inter-State Transfer Bridge—Minnesota Steel Co., New Duluth, Minnesota

General View of Minnesota Steel Company's Plant, Duluth, Minnesota

GREAT NORTHERN POWER COMPANY

¶ The Great Northern Power Company started a commercial operation July 1st, 1908, with ten customers, using 16,000 horsepower. Today it is supplying forty customers using 40,000 horsepower. These customers include railway companies, lighting companies in Duluth and Superior, also power for pumping the water supply to the city of Duluth and several miscellaneous customers including sixteen of the twenty-one coal docks at the head of the lakes.

¶ The installation consists of three 15,000 horsepower units and a 20,000 horsepower unit is to be put in this winter.

¶ The plant is fifteen miles from the center of the city and the present development has an effective head of 375 feet at the Power House. The company owns the further rights for a 70 foot development at Fond du Lac.

¶ Rates for power are lower than at any other lake port for similar service and range from one to two cents per kilowatt hour or from $10 to $30 per horsepower per year, depending upon the average use of horsepower installed.

¶ The Power Company can only handle customers with an installed capacity of 50 or more horsepower; the small customers being served by the local lighting companies in the two cities.

¶ The total capacity of the plant with no steam auxiliaries is 100,000 horsepower and with steam auxiliaries, this can be increased to a considerable extent.

Great Northern Power Co. Dam at Thompson

ZENITH FURNACE COMPANY

¶ In 1903 an organization was perfected at Duluth, having for its primary motive the manufacture of Bessemer and Foundry pig iron, for the purpose of supplying the trade tributary to the Head of the Lakes.

¶ Until the completion of the immense steel plant of the United States Steel Corporation, now under construction on the St Louis River, a few miles beyond the location of the Zenith Furnace Company, the latter will enjoy the distinction of operating the only blast furnace on the South Shore of Lake Superior producing Bessemer and Foundry coke iron.

¶ The most serious obstacle confronting the enterprise at its inception was the inability to obtain high grade coke at prices which were not prohibitive. This problem was eventually satisfactorily solved by the installation of a battery of fifty by-product coke ovens.

¶ The daily consumption of this battery of ovens is about 375 tons of the highest quality of Youghiogheny gas coal screenings, producing about 260 tons of Bessemer coke for blast furnace use.

¶ The by-products are gas, which is supplied to the cities of Duluth and Superior for illuminating, cooking and heating purposes, tar and ammonia.

¶ Only the purest Thin Vein Youghiogheny gas coal, mined in the Pittsburgh district, is suitable for the production of Zenith coke, and after the screenings are separated from the run of pile coal, which is received in cargo lots, the screened coal is sold to the steam and domestic trade in two sizes, which have long since become well and favorably known throughout the northwest under the names of Zenith Lump and Zenith Stove coal.

¶ The cleanest of preparation and promptness in filling shipping instructions have been specialties with the Zenith Furnace Company's dock organization, and to the latter end it operates its own terminal railway, in preference to depending upon the railroads for switching service.

¶ The annual capacity of the Zenith Furnace Company now aggregates about 600,000 tons of coal, 100,000 tons of coke, 75,000 tons of pig iron, 700,000,000 cubic feet of gas, 600,000 pounds of ammonia and 1,200,000 gallons of tar.

Blast Furnace—Zenith Furnace Company

The IRON RANGES of MINNESOTA

THE FIRST mention of iron bearing formation in this region is by Norwood in 1852, but it was not until 1875 that we have any record of work being done to establish the economic value of the district. In this year Prof. A. H. Chester examined the Missabe range from Embarrass Lake eastward to Birch Lake. In the greater portion of the district examined by Prof. Chester, the formation is highly magnetic and has never produced bodies of merchantable ore. Shortly after attention was almost wholly diverted from the Missabe by the discovery of ore on the Vermilion range.

¶ In the early 80's, Mr. Geo. C. Stone succeeded in interesting Mr. Charlemange Tower in the ore deposits on the Vermilion range near Tower. The first shipment of ore was made in 1884. In 1886 the whole property including mines, railroad, docks, and land grant was sold to the Minnesota Iron Company and later, on the organization of the U. S. Steel Corporation, became a part of the holdings of that corporation. The first mine to be developed near Ely, 21 miles east of Tower, was the Chandler, which began shipping in the fall of 1888. Since then the Pioneer, Zenith, Sibley and Savoy have been opened in what is known as the Ely trough. A new mine called the Section 30 is being worked on another trough about 3 miles east of Ely.

¶ On the Missabe range, ore was discovered in the fall of 1890 near the present Mountain Iron mine by the Messrs. Merritt of Duluth, and in the fall of the following year on the Biwabik property by the same parties. Since these discoveries the development of this range has been phenomenal.

¶ The Cuyuna Range was located from the results of magnetic work done by Mr. Cuyler Adams about the year 1895. Very little was done, other than magnetic research work, until the year 1904 when the first drilling was started in Sec. 16, Town 46, Range 28, about a mile southeast of Deerwood.

¶ The first shipment of ore from the Cuyuna Range was made in 1911 from the Kennedy mine.

¶ Minnesota furnishes yearly about three-fifths of the iron ore produced in the United States; the shipments during 1912 amounting to 34,197,501 tons.

Missabe Range	32,047,409 tons
Vermilion Range	1,844,981 tons
Cuyuna Range	305,111 tons
Lake Superior District	48,221,546 tons

TOTAL IRON ORE PRODUCED TO JAN. 1, 1913.

	Lake Superior District		574,125,258 tons
Minnesota	Missabe Range	279,067,325 tons	
	Vermilion Range	33,262,473 tons	
	Cuyuna Range	452,542 tons	—312,782,340 tons

VERMILION RANGE

THE VERMILION range extends from the vicinity of Tower to and beyond the international boundary, crossing into Canada at the eastern end of Hunter's Island. Merchantable bodies of ore have been discovered at but two localities along this extent, one at Tower and the other near Ely.

¶ The iron bearing formation of this range occupies the lowest position geologically of any of the Lake Superior iron formations, being designated by Van Hise and Clements as in the Archean.

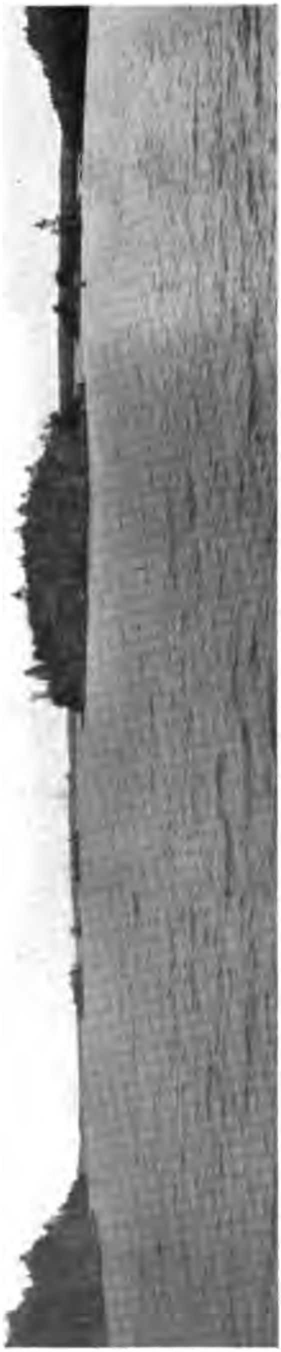
¶ At the Minnesota mine the ore is a dense hard hematite occuring in irregular connected and disconnected lense shaped bodies in the jasper, which is intricately infolded in the spheroidal greenstone or green schists, so-called on account of a characteristic spheroidal parting. The strike is about east and west and the dip approximately vertical with a westerly pitch. The underground workings at this mine are some 4,500 feet in extent east and west, and over 1,500 feet in depth. The structure here is probably the most complex in the Lake Superior iron districts. Above the iron bearing formation, geologically, comes the basal conglomerate of the Lower Huronian, arrying large boulders and masses of the iron bearing rocks.

¶ The ores at Ely differ from the preceeding, mainly in their physical structure, being much more broken and friable. The area in which they lie is a double ended trough about two miles in length east and west and some 1,500 feet in width. The general dip is nearly vertical and the pitch of the ore bodies at the west end of the trough, is to the east, while the pitch of those at the east end is to the west. The iron formation here, as at the Minnesota mine, lies in a trough of the older spheroidal greenstone, but the folding is not so close. Intrusive masses and dikes of granitic porphyry and basic eruptives cut the whole series.

Soudan Mine near Tower—Where iron ore was first mined in Minnesota

A Shaft, Pioneer Mine, Ely, Minnesota

B Shaft, Pioneer Mine, Ely, Minnesota



Long Lake near Ely, Minnesota

MISSABE RANGE

¶ The ores of the Missabe are red, brown and yellow hematites and limonites, more or less hydrated, and are secondary replacements or enrichments of the jasper. They are supposed to be mainly derived from the silicates of iron, which are abundant in the rocks of the iron formation, and to a less degree from siderite. In physical structure they vary from a fairly compact phase to earthy or powdery phases, and are comparatively high in moisture. At the west end of the range the ores are more or less "sandy," a condition evidently resulting from the decomposition of the cherty layers in the banded iron and chert.

¶ The first ore from the Missabe range was shipped from the Mountain Iron mine over the Duluth, Missabe & Northern Railroad in 1892. The total shipments during that year amounted to 4,248 tons. Since that time the Mountain Iron mine has produced 17,200,000 tons.

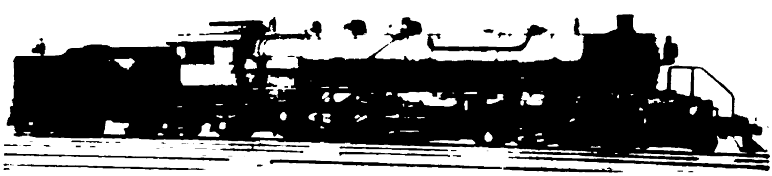
IRON ORE PRODUCTION.

1911	- - - - - -	22,093,532 tons
1912	- - - - - -	32,047,409 "
Total to January 1, 1913	- -	279,067,325 "

¶ Since the Missabe range opened there has been removed 205,949,000 cubic yards of stripping. The total excavation, taking into account the ore and stripping, is as follows:

1892 to 1900 stripping	-	22,089,000 cu. yds.
1901 to 1913 "	-	183,860,000 " "
1892 to 1900 ore (estimated)		15,700,000 " "
1901 to 1913 ore	-	123,833,600 " "
Grand Total	-	345,482,600 " "

¶ Besides this, 5,000,000 cubic yards of lean ore has been put in stock pile. The total excavation for the Panama Canal is, according to the latest figures, 218,138,300 cubic yards.



List of Mines on the Missabe Range

With Name of Mine, Operating Company and Estimated Shipments for 1913.

OLIVER IRON MINING COMPANY'S MINES

Mine	*Operating Company*	*Estimated Shipm'ts '13*
Adams	Oliver Iron Mining Company	932,000
Auburn	Oliver Iron Mining Company	......
Burt-Pool-Day	Oliver Iron Mining Company	695,000
Canisteo	Oliver Iron Mining Company	1,100,000
Canton	Oliver Iron Mining Company	......
Chisholm	Oliver Iron Mining Company	600,000
Clark	Oliver Iron Mining Company	450,000
Dale	Oliver Iron Mining Company	560,000
Duluth	Oliver Iron Mining Company	......
Fay	Oliver Iron Mining Company	260,000
Fayal	Oliver Iron Mining Company	1,271,000
Genoa-Sparta	Oliver Iron Mining Company	1,020,000
Gilbert	Oliver Iron Mining Company	185,000
Glen	Oliver Iron Mining Company	......
Graham	Oliver Iron Mining Company	100,000
Harold	Oliver Iron Mining Company	245,000
Hartley	Oliver Iron Mining Company	......
Higgins	Oliver Iron Mining Company	......
Hill	Oliver Iron Mining Company	810,000
Holman	Oliver Iron Mining Company	775,000
Hull-Rust	Oliver Iron Mining Company	3,742,000
Judd	Oliver Iron Mining Company	100,000
Leonard	Oliver Iron Mining Company	1,525,000
Leonidas	Oliver Iron Mining Company	555,000
Lone Jack	Oliver Iron Mining Company	......
McKinley	Oliver Iron Mining Company	......
Mace	Oliver Iron Mining Company	150,000
Minnewas	Oliver Iron Mining Company	......
Missabe Mountain	Oliver Iron Mining Company	325,000
Mississippi	Oliver Iron Mining Company	275,000
Monroe-Tener	Oliver Iron Mining Company	500,000
Morris	Oliver Iron Mining Company	......
Mountain Iron	Oliver Iron Mining Company	......
Myers	Oliver Iron Mining Company	90,000
Norman	Oliver Iron Mining Company	400,000
Ohio	Oliver Iron Mining Company	......
Pillsbury	Oliver Iron Mining Company	......
Sauntry-Alpena	Oliver Iron Mining Company	1,600,000
Sellers	Oliver Iron Mining Company	244,000
Sharon	Oliver Iron Mining Company	......
Spruce	Oliver Iron Mining Company	750,000
Stephens	Oliver Iron Mining Company	......

Mine	Operating Company	Estimated Shipm'ts '13
St. Clair	Oliver Iron Mining Company	......
Sullivan	Oliver Iron Mining Company	......
Uno—North	Oliver Iron Mining Company	275,000
Uno—South	Oliver Iron Mining Company	875,000
Vivian	Oliver Iron Mining Company	15,000
Walker	Oliver Iron Mining Company	......
Weed	Oliver Iron Mining Company	......
Winifred	Oliver Iron Mining Company	40,000
Total		20,464,000

PICKANDS, MATHER & COMPANY'S MINES

Albany	Pickands, Mather & Company	350,000
Bangor	Pickands, Mather & Company	130,000
Corsica	Pickands, Mather & Company	250,000
Elba	Pickands, Mather & Company	125,000
Hudson	Pickands, Mather & Company	250,000
Kellogg	Pickands, Mather & Company	......
Malta	Pickands, Mather & Company	90,000
Minorca	Pickands, Mather & Company	80,000
Mohawk	Pickands, Mather & Company	200,000
Scranton	Pickands, Mather & Company	240,000
Troy	Pickands, Mather & Company	70,000
Utica	Pickands, Mather & Company	350,000
Virginia	Pickands, Mather & Company	350,000
Yawkey	Pickands, Mather & Company	50,000
Total		2,535,000

REPUBLIC IRON & STEEL COMPANY'S MINES

Bray	Republic Iron & Steel Company	100,000
Franklin	Republic Iron & Steel Company	50,000
Kinney	Republic Iron & Steel Company	500,000
Mariska	Republic Iron & Steel Company	......
Monica	Republic Iron & Steel Company	75,000
Onondaga	Republic Iron & Steel Company	40,000
Pettit	Republic Iron & Steel Company	200,000
Schley	Republic Iron & Steel Company	200,000
Union	Republic Iron & Steel Company	285,000
Victoria	Republic Iron & Steel Company	......
Wills	Republic Iron & Steel Company	......
Total		1,450,000

M. A. HANNA & COMPANY'S MINES

Brunt	M. A. Hanna & Company	200,000
Croxton	M. A. Hanna & Company	75,000
Frantz	M. A. Hanna & Company	......
Hanna	M. A. Hanna & Company	300,000

Mine	*Operating Company*	*Estimated Shipm'ts '13*
Hobart	M. A. Hanna & Company	......
La Rue	M. A. Hanna & Company	250,000
Sliver	M. A. Hanna & Company	325,000
Total		1,150,000

JOSEPH SELLWOOD GROUP OF MINES

Adriatic	Joseph Sellwood	125,000
Cyprus	Joseph Sellwood	100,000
Morrow	Joseph Sellwood	100,000
Pearson	Joseph Sellwood	125,000
Perkins	Joseph Sellwood	150,000
Total		600,000

THE SHENANGO FURNACE COMPANY'S MINES

Shenango	The Shenango Furnace Company	1,000,000
Webb	The Shenango Furnace Company	300,000
Whiteside	The Shenango Furnace Company	300,000
Total		1,600,000

JONES & LAUGHLIN STEEL COMPANY'S MINES

Columbia	Jones & Laughlin Steel Company	......
Fowler-Meadow	Jones & Laughlin Steel Company	100,000
Grant	Jones & Laughlin Steel Company	650,000
Leetonia	Jones & Laughlin Steel Company	500,000
Lincoln	Jones & Laughlin Steel Company	200,000
Longyear	Jones & Laughlin Steel Company	200,000
Nassau	Jones & Laughlin Steel Company	......
Total		1,650,000

PITT IRON MINING COMPANY'S MINES

La Belle	Pitt Iron Mining Company	15,000
Miller	Pitt Iron Mining Company	350,000
Ruddy	Pitt Iron Mining Company	40,000
Wacotah	Pitt Iron Mining Company	......
Total		405,000

A. B. COATES GROUP OF MINES

Madrid	A. B. Coates	95,000
Section 17	A. B. Coates	30,000
Seville	A. B. Coates	5,000
Total		130,000

ARTHUR IRON MINING COMPANY'S MINES

Mine	*Operating Company*	*Estimated Shipm'ts '13*
	(Great Northern Ore Properties)	
Dean	Arthur Iron Mining Company	......
Dunwoody	Arthur Iron Mining Company	......
Smith	Arthur Iron Mining Company	......

GEO. A. ST. CLAIR GROUP OF MINES

Spring	Geo. A. St. Clair	......
Silverton	Geo. A. St. Clair	......
Ajax	Geo. A. St. Clair	......
Hector	Geo. A. St. Clair	......

CORRIGAN, McKINNEY & COMPANY'S MINES

St. James	Corrigan, McKinney & Company	......
St. Paul	Corrigan, McKinney & Company	......
Stevenson	Corrigan, McKinney & Company	600,000
Commodore	Corrigan, McKinney & Company	1,000,000
Total		1,600,000

INTERNATIONAL HARVESTER COMPANY'S MINES

Agnew	International Harvester Company	100,000
Hawkins	International Harvester Company	500,000
Total		600,000

OGLEBAY, NORTON & COMPANY'S MINES

Woodbridge	Oglebay, Norton & Company	150,000

BUFFALO & SUSQUEHANNA COMPANY'S MINES

	(Rogers-Brown Ore Company)	
Iroquois	Buffalo & Susquehanna Company	150,000
Susquehanna	Buffalo & Susquehanna Company	1,100,000
Total		1,250,000

NEW YORK STATE STEEL COMPANY'S MINES

Knox	H. F. Kendall, Receiver	20,000

INLAND STEEL COMPANY'S MINES

Grace	Inland Steel Company	100,000
Laura	Inland Steel Company	200,000
Total		300,000

MAHONING ORE & STEEL COMPANY'S MINES

Mine	*Operating Company*	*Estimated Shipm'ts '13*
Mahoning	Mahoning Ore & Steel Company	2,000,000

TOD-STAMBAUGH COMPANY'S MINES

Morton	Tod-Stambaugh & Company	150,000

CLEVELAND-CLIFFS IRON COMPANY'S MINES

Crosby	Cleveland-Cliffs Iron Company	250,000

BIWABIK MINING COMPANY'S MINES

(Tod-Stambaugh & Co.)

Biwabik	Biwabik Mining Company	300,000
Cincinnati	Biwabik Mining Company	......
Total		300,000

CLARE IRON COMPANY'S MINES

Elizabeth	Clare Iron Company	......

MERIDEN IRON COMPANY'S MINES

Pearce	Meriden Iron Company	120,000

SWALLOW & HOPKINS' MINES

Helmer	Swallow & Hopkins	50,000

KEEWATIN MINING COMPANY'S MINES

Bennett	Keewatin Mining Company	......

KABEKONA IRON COMPANY'S MINES

Kabekona	Kabekona Iron Company	......

CAVOUR MINING COMPANY'S MINES

Cavour	Cavour Mining Company	150,000
	D. C. REED (Virginia, Minn.)	
Roberts	D. C. Reed	......

YAWKEY ESTATE

Larkin	Yawkey Estate	......

MORRIS IRON COMPANY'S MINES

Mine	*Operating Company*	*Estimated Shipm'ts '13*
Allen	Morris Iron Company	50,000

SECTION 4 MINES COMPANY'S MINES

Section 4	Section 4 Mines Company	......

THOMAS FURNACE COMPANY'S MINES

Williams	Thomas Furnace Company	135,000

REDWOOD MINING COMPANY'S MINES

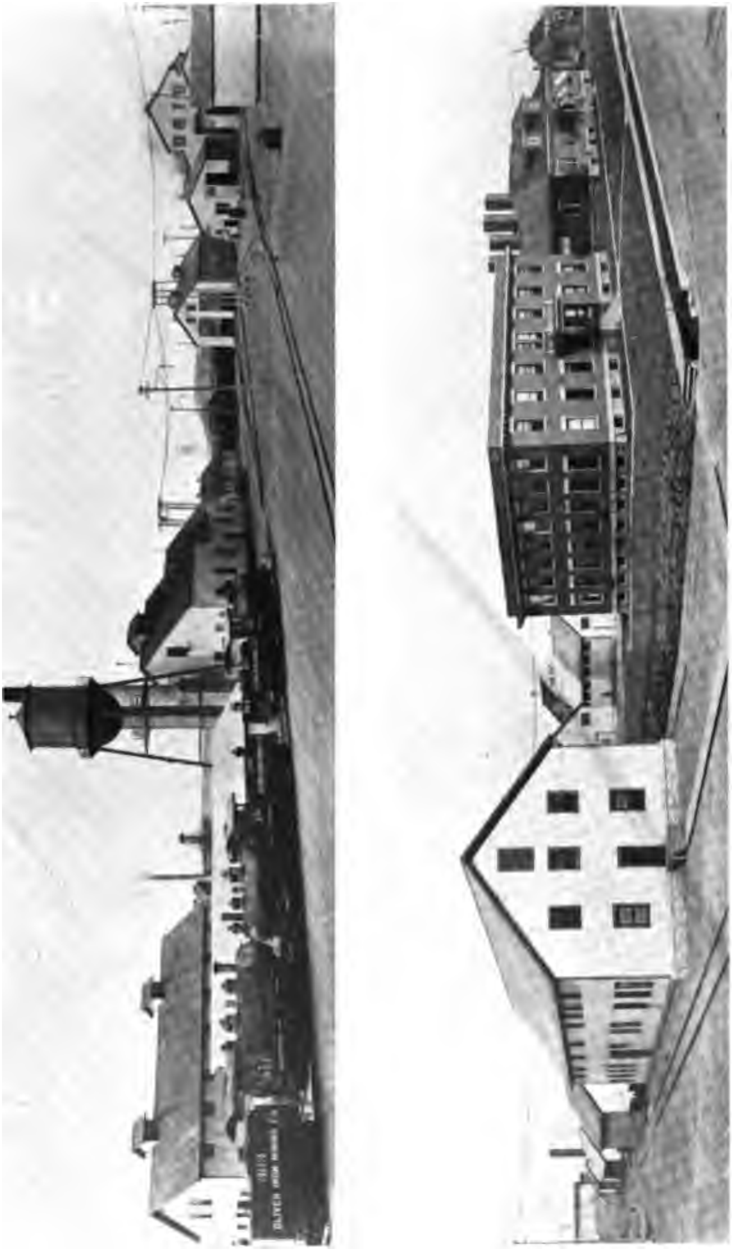
Holland	Redwood Mining Company	......

WHITE IRON LAKE IRON COMPANY'S MINES

Euclid	White Iron Lake Iron Company	25,000
Grand Total		37,134,000

Mountain Iron Mine, Mountain Iron, Minnesota—The first shipper of the Missabe Range. Total Shipments, 17,198,871 tons.

Republic Iron & Steel Co.'s Schley Mine, Gilbert Minn.



Headquarters Oliver Iron Mining Company, Hibbing, Minnesota—Showing Shops, Office, and Laboratory

Pickands-Mather & Co.'s Elba and Corsica Mines — McKinley, Minnesota.

Mahoning Mine, Hibbing, Minnesota—Total shipments 16,577,443 tons

Hull-Rust Mine, Hibbing, Minnesota—Total Shipments, 20,958,235 tons

Headquarters Oliver Iron Mining Company, Virginia, Minnesota—Showing Club House, Laboratory, Office, and Shop Buildings

Mine Location Virginia, Minnesota

A Type of Sanitary Alley, Mine Location—Virginia, Minnesota

Fayal Mine, Eveleth, Minnesota—Total Shipments, 20,520,032 tons

Interior View of Bray Mine Change House, Keewatin, Minnesota.

Brunt Mine—Ore Dryer, Mountain Iron, Minnesota.
Plant consists of two dryers, each of a capacity of 40 tons of dried ore per hour, and two dryers each of a capacity of 20 tons of dried ore per hour. Ore is reduced in moisture from around 18 per cent to 6 per cent

No. 4 Shaft, Spruce Mine, Eveleth, Minnesota

Mine Location—Monroe Mine, Chisholm, Minnesota

Safety Houses—Men use these to protect themselves from flying material hurled by blasting in the pits

Type of Engine used on the Missabe Range.
Note the guard railings for protection of men.

Kinney Mine, Nashwauk, Minnesota

Concentrating Plant, Coleraine, Minnesota

¶ A large portion of the ore on the Western Missabe Range occurs mixed with sand, making it necessary to build washing plants to remove the worthless material and bring the ore to a merchantable grade.

¶ The Concentrating Plant at Coleraine consists of five units, each unit comprising the following:

1 Receiving bin,
1–20 ft. revolving screen, 2 in. holes,
1 Picking belt,
2–25 ft. log washers,
2–18 ft. "turbo" washers,
20 Overstrom tables,
1 Shipping pocket,
Necessary settling tanks, rock bins, sand pumps and driving mechanism.

¶ Each unit is operated by a 100 h. p. motor. The capacity of each unit is 4,000 tons of crude ore per day, or a total of 20,000 tons per day.

¶ All structural work was furnished and erected by The American Bridge Co.

¶ In the mill, trestle and tail track, there are 6,400 tons of steel.

¶ The Power Plant comprises the following:

6–72 in.x18 ft. H. T. boilers with tile stack.
1–26x52 and 16x48 Prescott, Cross Compound, Condensing Pumping-engine; capacity 12,000,000 gallons, delivering through a 30 in. steel main to mill,
1–26 and 52x48 Cross Compound, Condensing, Corliss engine, direct connected to 1250 K. V. A., 6,600 volt, 60 cycle generator.
The necessary exciter sets, (switchboard, transformers, etc.)

Views of Coleraine, Minnesota

CUYUNA RANGE

¶ The Cuyuna Range lies in the vicinity of Deerwood, 100 miles west of Duluth.

¶ The occurrence of the ore deposits on the Cuyuna Range differs greatly from that of the Missabe. The Cuyuna, in a broad sense, occurs as a series of detached lenses or bodies of iron bearing material, in connection with the great slate area which abounds throughout this section of the State. Within these lenses of iron bearing rocks, the ore deposits are found. The ore bodies dip steeply from the horizontal, conforming to the dip of the slates, their long dimensions being about parallel and lying in a northeast and southwest direction. The south range consists of a long, narrow belt, containing a series of iron formation lenses, lying close together, parallel and overlapping. The deposits on the north range are more scattered and cover a larger area.

¶ The Kennedy is the pioneer mine of this range. This property is worked by the Rogers Brown Company.

¶ Shipments from the Cuyuna Range began in 1911 and to Jan. 1, 1913 amounted to 452,542 tons. In 1912 there were four producing mines; Kennedy, Armour No. 1, Armour No. 2 and Thompson. Other properties are being opened; one called the Pennington is to be stripped and the ore mined by steam shovel.

Kennedy Mine, Cuyuna Range

Armour Mine, No. 1, Cuyuna Range

RAILROADS

DULUTH & IRON RANGE RAILROAD.

¶ The Duluth & Iron Range Railroad was built from Two Harbors to the Vermilion Range at Tower, a distance of 67.6 miles, in 1884, and extended to Ely, 21 miles east of Tower, in 1888. It was built into Duluth in 1886, and branches were extended from its main line to the Missabe mines in 1892 and 1893.

DULUTH, MISSABE & NORTHERN RAILWAY.

¶ The Duluth, Missabe & Northern Railway was constructed from Stony Brook to Mountain Iron, a distance of 48 miles, in 1892. The Biwabik branch from Iron Junction to Biwabik, a distance of 15 miles, was constructed in 1892. The Superior branch from Wolf to Hibbing, a distance of 16 miles, was constructed in 1893. The Duluth extension from Columbia Junction to Duluth, a distance of 29 miles, was completed in 1893. The Alborn branch from Coleraine Junction to Coleraine, a distance of 53 miles, was constructed in 1906. The Hull-Rust short line from Hull Junction to Hull-Rust Mine, 18 miles, was built in 1911.

GREAT NORTHERN RAILWAY LINE.

Missabe Division.

¶ The Great Northern Railway Line acquired what is now its Missabe Division, over which line ore is transported from Missabe Range mines to docks at Allouez, Wisconsin, by purchase of the Duluth, Superior and Western Railway (Duluth and Winnipeg) in 1898. At time of purchase this line extended from Duluth to Deer River, connecting with the Duluth, Mississippi River and Northern Railway at Swan River, this latter road extending to the mines. In 1898 the purchase of the Duluth and Mississippi River and Northern Road was affected, which gave the Great Northern a line through to Barclay Junction, (now Chisholm), Minnesota. In 1900 and 1901 extension was built from Barclay Junction to Virginia, and in 1901 and 1902 line was built from Ellis (near Virginia) to a point on the old D. S. & W., at Brookston. In 1902 and 1903 what is now designated as the "South Range Line" was constructed from Hibbing to Virginia. There has also been built a "cut-off" known as the Kelly Lake Fermoy Line.

¶ All the roads mentioned above transport ore from the Missabe Range. The Duluth & Iron Range handles the ore from the Vermilion District.

¶ The following shows the general equipment of the ore carrying roads necessary for the handling of the enormous yearly tonnage from the Missabe and Vermilion Ranges:

Road	Mileage	No. of Engines	No. of Cars
Duluth & Iron Range	200	104	5627
Duluth, Missabe & Northern	351	110	7687
Great Northern (Missabe Division)	310	75	6876

¶ The Canadian Northern Railroad between Fort Frances and Duluth is now finished. This road passes through Virginia and later will no doubt carry ore from the Missabe Range.

¶ In the summer of 1910 the Soo line finished a branch road to the Kennedy mine and later to other properties on the Cuyuna Range. This together with the Northern Pacific, gives the district two railroads. The ore shipped so far has been handled by the Soo Line from their dock at Superior.

¶ The Northern Pacific is now building a dock at Superior. It will be ready in August 1913.

The following tabulation gives the distance in miles of Range towns from Duluth:

TOWN	RANGE	RAILROAD	DISTANCE
Ely	Vermilion	D. & I. R.	116
Tower	Vermilion	D. & I. R.	98
Allen Junction	Junction Point	D. & I. R.	73
Two Harbors	Ore Docks	D. & I. R.	27
Biwabik	Missabe	D. & I. R.	87
Biwabik	Missabe	D. M. & N.	78
Virginia	Missabe	D. & I. R.	97
Virginia	Missabe	D. M. & N.	72
Eveleth	Missabe	D. & I. R.	100
Eveleth	Missabe	D. M. & N.	69
Mountain Iron	Missabe	D. M. & N.	72
Chisholm	Missabe	D. M. & N.	81
Hibbing	Missabe	D. M. & N.	84
Marble	Missabe	D. M. & N.	77
Taconite	Missabe	D. M. & N.	82
Coleraine	Missabe	D. M. & N.	86

Section of D. M. & N. Ry. Main Line, showing double track, 100-lbs. to the yard rail, steel ties and rock ballast

50 miles of track for the storage of ore—Proctor, Minnesota, D. M. & N. Ry.

Right-of-way on the Duluth & Iron Range Railroad

This right-of-way is conceded by State Foresters to be in ideal condition and an example for all railroads in similar districts

ORE DOCKS

Duluth & Iron Range Ore Docks at Two Harbors.

Dock No.	Length Ft.	Width Ft.	Width In.	Working, Storage Capacity Tons
1 (Steel)	1376	51	8	56,000
2	1280	49		31,200
3	1054	49		25,500
4	1042	49		25,200
5	1050	49		25,200
6 (Steel)	920	51	3¼	37,000
		Total Tons	-	200,100

Duluth, Missabe & Northern Ore Docks at Duluth.

Dock No.	Length Ft.	Width Ft.	Working, Storage Capacity Tons
2	2336	49	38,400
3	2304	59	57,600
4	2304	57	76,800
		Total Tons -	172,800

Great Northern Ore Docks at Superior, Wis.

Dock No.	Length Ft.	Width Ft.	Width In.	Working, Storage Capacity Tons
1	2244	62	8	112,200
2	2100	62	8	105,000
3	1956	62	8	97,800
4 (Steel)	1812	62	6	90,600
		Total Tons	-	405,600

Minneapolis, St. Paul & Sault Ste. Marie Ry., at Superior, Wis.

Dock No.	Length Ft.	Width Ft.	Working, Storage Capacity Tons
1	1800	58	90,000

Northern Pacific Railway at Superior, Wis.

Dock No.	Length Ft.	Width Ft.	Width In.	Working, Storage Capacity Tons
1	684	572		35,700

During 1912, 10,495,577 tons of ore was handled by the Duluth, Missabe & Northern Railway from the West Duluth docks; 9,370,969 tons by the Duluth & Iron Range at Two Harbors; 13,935,602 tons by the Great Northern and 305,112 tons by the Soo Line from their docks in Superior.

Duluth & Iron Range R. R. Ore Docks—Two Harbors, Minnesota

One of the Great Northern Ry. Ore Docks—Superior, Wisconsin

LAKE TRANSPORTATION

ONE of the first ships of commerce to arrive in the harbor of Duluth was the Meteor, in September, 1868. The capacity of this boat was about 500 tons. The first cargo of ore shipped from Minnesota was carried by the steamer Hecla. This ore was loaded on August 19, 1884, at Two Harbors at the Duluth & Iron Range dock and consisted of 1427 tons.

¶ At the present time there are about 400 boats used for the ore carrying trade. The capacity of this fleet is estimated around 55,000,000 tons of ore a season. This is in addition to the transportation of coal and grain.

¶ The Pittsburgh Steamship Company owns 105 boats.

¶ During 1912 ore was carried on the Great Lakes over an average distance of 1,000 miles for as low as 50 cents a ton, the boat owners paying the unloading charge of 10 cents a ton.

¶ The following will give an idea of the size of the newer boats constituting a part of the ore carrying fleet:

STEAMER	Length Feet	Width Feet	Tonnage Gross Tons
Col. J. N. Schoonmaker - -	617	64	14,000
W. P. Snyder, Jr. - - -	617	64	14,000
Thomas F. Cole - - -	605	58	12,000
L. S. DeGraff - - - -	605	60	12,900
W. B. Kerr - - - -	605	60	12,300

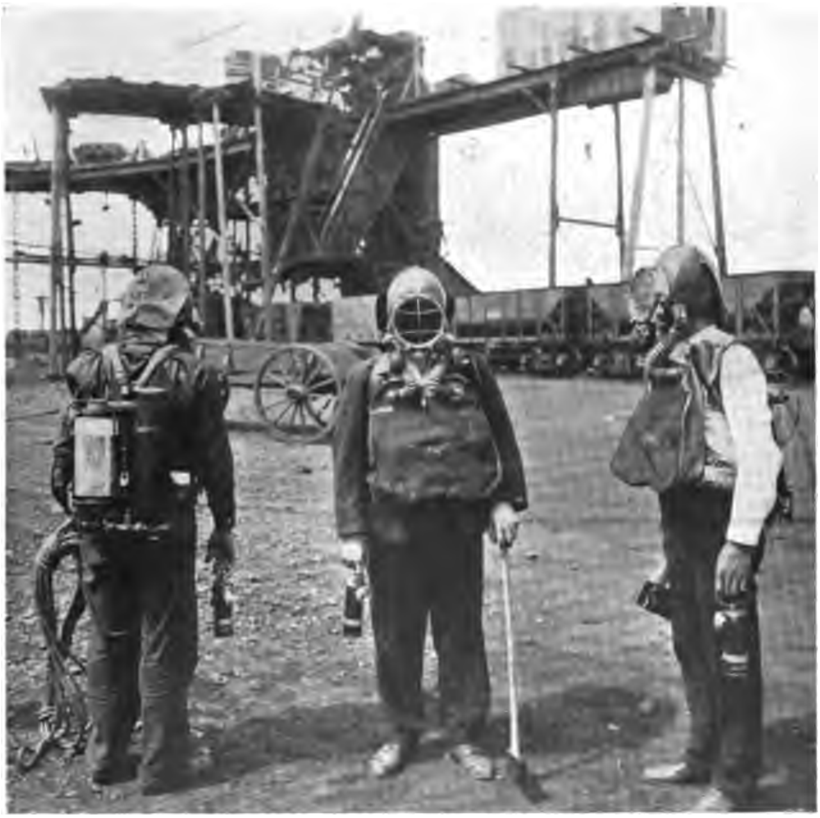
¶ The usual time of loading an ordinary size boat of about 10,000 tons is six hours. The steamer Corey was loaded at Superior, September 8, 1911, with 9,456 gross tons of ore in twenty-five minutes (actual time loading). The steamer W. P. Palmer unloaded 11,000 tons of ore at Conneaut in two hours and fifty-eight minutes.

Type of Ore Carrier on Great Lakes—Boats ply the Great Lakes carrying iron ore, grain and coal

Loading Boat at Ore Docks

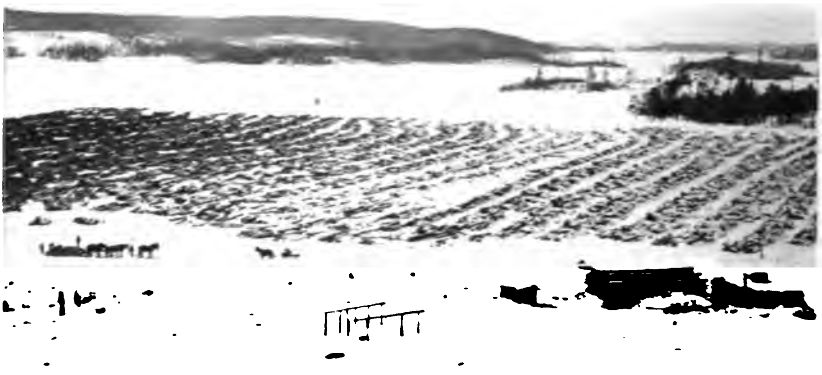
Fire Tug, W. A. McGonagle

Type of Steam Shovel used on the Missabe Range.
Note the complete covering of the gear wheels for safe-guarding the men



Draeger Oxygen Apparatus—Used in case of fire or bad air to extricate men from dangerous places

mines



Mining timber logs being stored in the east arm of Burntside Lake

Driving mining timber logs down the Cloquet River

Loading assorted mining timber logs on cars for shipment to the mines

Logging crew eating dinner in the open on the works

The Virginia and Rainy Lake Co.'s Mill, Virginia, Minnesota. Capacity 1,000,000 feet of lumber daily. Plant covers over 300 acres of ground and employs around 1400 men.

Logging Camps on Bass Lake, showing Mess Camp, Sleeping Camp, Blacksmith Shop, Office and Stables